INVESTIGATION OF WELDING THERMAL STRAINS IN MARINE STEELS

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BY

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ABSTRACT

The stress-strain-temperature response of metal plates during welding is discussed and current efforts to analyze the phenomena are outlined. Transient strain and temperature data obtained from welding experiments on HY-80, HY-130, low carbon and maraging steels are presented. The experiments were designed to approximate ship structural weldments including thick-section, multi-pass butt welds.

The experimental data are compared to analytical predictions obtained from computer programs developed for the National Aeronautics and Space Administration. Results indicate that the programs can be used to analyze complex structural weldments applicable to ship and submarine fabrication. It was also found that the effects of thick-section, multi-pass welding are more pronounced in the early passes and tend to level off as deposited weld metal increases. The transient strain response of both thin and thick section plates was found to be predominantly longitudinal

except in the immediate area of the welding arc itself. The maximum mechanical strains observed on plates of varying strength levels were found to be roughly proportional to the inverse of the base plate yield strength. Finally, the strain plots of the two highest strength steels were characterized by unusual secondary tensile peaks which may be linked to phase transformations in the heat affected zone during cool-down.

Several recommendations are made concerning further investigations aimed at developing the NASA programs and subsequent experiments into shipyard design and production tools.

THESIS SUPERVISOR: Koichi Masubuchi

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NOMENCLATURE

v	travel speed of welding arc
ΔT	change in temperature
σ_x	stress in x-direction
σ_y	stress in y-direction
τ_{xy}	shear stress
psi	pounds-per-square-inch
ksi	pounds-per-square-inch × 1,000
GMA	Gas Metal Arc welding process, also known as MIG (Metal Inert Gas)
ΔR	change in resistance
$\Delta R(\varepsilon_e)$	change in resistance corresponding to elastic mechanical strain
$\Delta R(\varepsilon_p)$	change in resistance corresponding to plastic mechanical strain
$\Delta R(\alpha T)$	change in resistance corresponding to temperature induced thermal strain
$\Delta R(T)$	change in resistance caused by thermo-electric effects in the strain gage
°F	temperature in degrees Fahrenheit
DCRP	direct current, reversed polarity (electrode positive, plate negative)
ipm	inches-per-minute (a measure of travel speed)
O_2	molecular Oxygen (gaseous)
microstrain	10^{-6} inches-per-inch elongation (or contraction)

I INTRODUCTION

A. Background

In the fabrication of complex welded structures, several serious problems are caused by the occurance of welding thermal strains. Distortion, strain aging and high residual stresses can be traced directly to this phenomenon. Unfortunately, thermal strains are inherent in the welding process. They result primarily from plastic flow accompanying localized arc heating. (A detailed discussion of the mechanism will be presented later.) If welding thermal strains cannot be prevented, structural safety and reliability demand that they be controlled. This concept is critical in the fabrication of modern ships and submarines.

The distortion problem in ship construction is well documented. Distortion often prevents the achievement of design tolerances, reduces joint strength by mismatching, and imparts initial deflections into structural members.[1,2,3] Corrugation of shell plating is a common distortion-induced failure in surface ships; in submarines, shape imperfections caused by weld distortion can result in premature yielding and hull failure by general instability.[4]

The problems associated with residual stresses are equally ominous. Several investigators have established the role of residual welding stresses in the initiation of low-stress brittle fracture.[5,6] Below a certain temperature, normally ductile steels will fail catastrophically in the

presence of high tensile stresses and some sharp notch such as a weld crack or lack-of-fusion defect. Since residual welding stresses are often at or near the base plate yield strength, brittle fracture of welded structures can and has occurred at very low applied stress levels.

The development of high strength submarine steels has recently added a new dimension to the residual stress problem. Both quenched-and-tempered and maraging-type steels have been found highly susceptible to hydrogen embrittlement. At strength levels above 180-ksi, maraging steels have suffered stress corrosion cracking and hydrogen embrittlement in ordinary marine environments.[7,8] The exact mechanism controlling these failure modes has been the subject of considerable dispute, but both are characterized by time-dependent brittle fracture in areas of localized high tensile stress.[9]

The problem of distortion and residual stress can be considered part of the cummulative results of welding processes. The transient strain response produced by a moving welding arc gives rise to yet another deleterious effect--strain aging. This term refers to the loss in ductility observed in certain steels undergoing plastic deformation during particular periods of time. Strain aging is strongly dependent on temperature and appears sensitive to tension-compression cycling.[10] Coupled with possible phase transformations in the heat-affected zone, weld-induced strain aging can result in severe degradation of the physical properties of the base plate.

B. Welding Stress-Strain Development

The mechanism by which thermal stresses and strains are developed in welded plates has been described by Dr. Koichi Masubuchi.[11] The description is based on current theories of heat flow and stress-strain-temperature relationships. It begins by recognizing that a weldment is locally heated by the welding arc, and the temperature in the metal is therefore not uniform and changes as welding progresses. This non-uniform temperature distribution causes thermal strains and stresses in the weldment which also change during the process.

Figure 1 shows schematically how welding thermal stresses are formed. Figure 1a indicates a bead-on-plate weld in which a weld bead is being deposited at a speed, v. O-xy is the coordinate system; the origin, O, is on the surface underneath the welding arc, and the x-direction lies in the direction of arc travel.

Figure 1b shows the temperature distribution along several cross sections. Along Section A-A, which is ahead of the arc, the temperature change due to welding, ΔT, is almost zero (Figure 1b-1). Along Section B-B, which crosses the welding arc, the temperature distribution is very steep (Figure 1b-2). Along Section C-C, some distance behind the arc, the distribution of temperature is as indicated in Figure 1b-3. Far behind the arc (Section D-D), the temperature change due to welding again diminishes (Figure 1b-4).

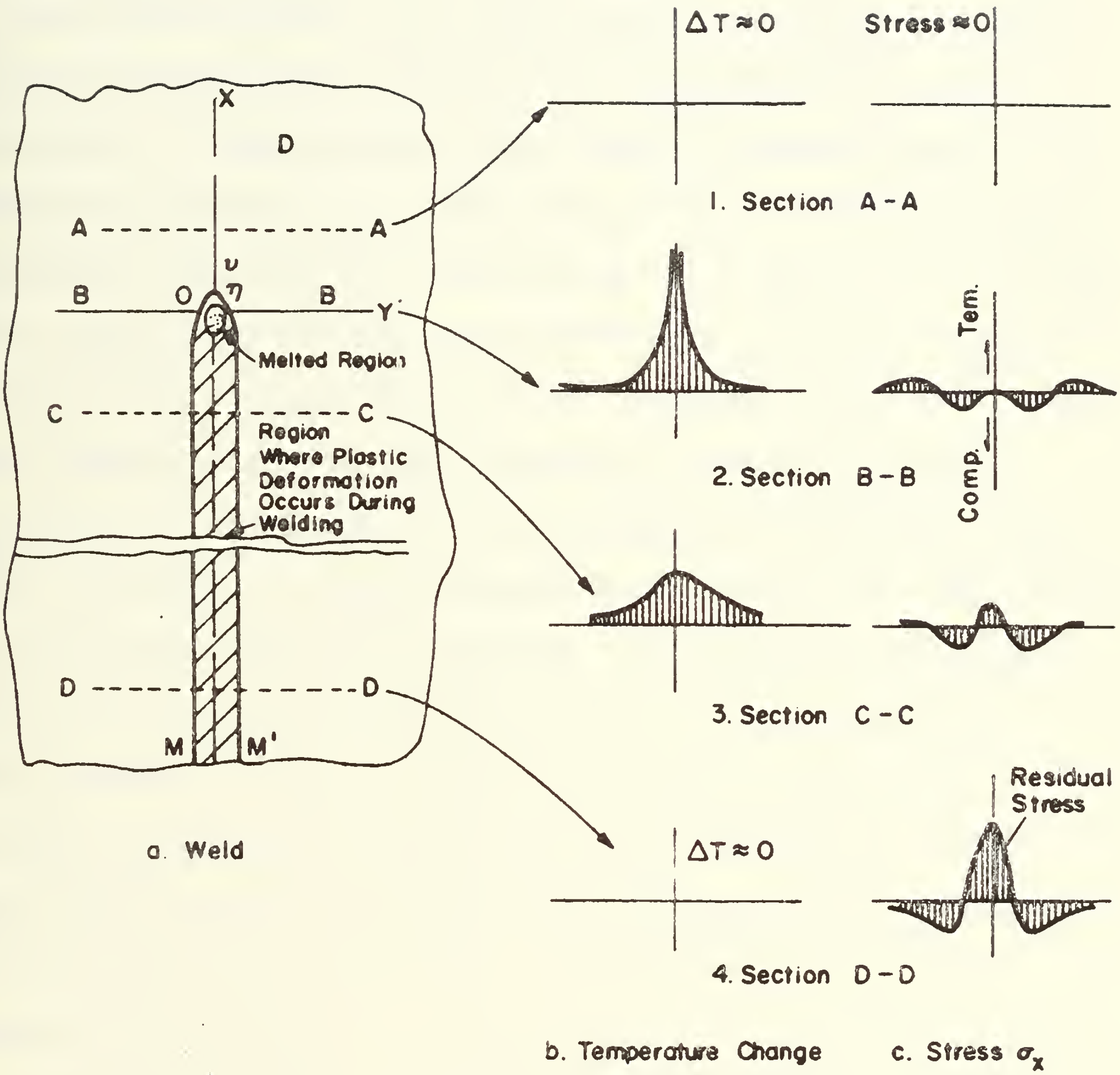


Figure 1. Schematic Representation of Changes of Temperature and Stresses During Welding

Figure 1c shows the distribution along these sections of the x-direction stress, σ_x. Stress in the y-direction, σ_y, and shear stress, τ_{xy}, also exist in a two dimensional stress field but are secondary and are neglected in this discussion. Along Section A-A, thermal stresses due to welding are essentially zero (Figure 1c-1). The stress distribution along Section B-B is shown in Figure 1c-2. In the area beneath the welding arc stresses are near zero because molten metal cannot support loads. Immediately outside the weld puddle, stresses are compressive because thermal expansion of these areas is restrained by surrounding areas that are heated to lower temperatures. Since the temperatures of the areas immediately adjacent to the puddle are quite high and the strength of the material is correspondingly low, stresses in these areas are as high as the yield strength and plastic straining occurs. Stresses in areas away from the weld are tensile and balance with the compressive stresses near the weld. In other words, $\int\sigma_x \cdot dy = 0$ across Section B-B.

The distribution along Section C-C is shown in Figure 1c-3. Here the weld metal and base metal regions near the weld are cooling and tend to shrink. This causes tensile stresses in these regions near the weld and compressive stresses in areas further away.

Figure 1c-4 shows the stress distribution along Section D-D. Continued cooling and shrinkage has left very high

tensile stresses in and near the weld, and offsetting compressive stresses across the rest of the section. This is the residual stress distribution after complete cool-down.

Note that the cross-hatched area, MM', in Figure 1a indicates the region where plastic deformation occurs during the welding thermal cycle. The region outside MM' remains elastic during the entire cycle.

C. Previous Investigations

In spite of an enormous research effort expended over the years, understanding and control of the complex mechanisms producing welding thermal strains have been elusive. Interpretive reviews by Kihara and Masubuchi provide an indication of the progress in the field as well as extensive bibliographies.[2,11] The closest approach to a break-through so far has been the development by several authors of computerized models of simplified welding theories. The Prokhorovs in Russia and Tall in this country have produced significant results in this area in the last few years.[12,13] In order to expand and apply the available knowledge, NASA's George C. Marshall Space Flight Center supported continuing studies at Battelle Memorial Institute and the Massachusetts Institute of Technology on a quantitative analysis of thermal stresses and metal movement during welding. The most important result to date has been the development by Masubuchi and others of a one dimensional computer model applicable to bead-on-plate and butt welds of thin plates.[14]

While the use of high speed computers has led to impressive analytical progress, a distinct lack of complete and reliable experimental data has retarded further advances. Attempts to physically verify analytical results have been incomplete and often contradictory. The most common experimental techniques have involved some type of post-weld stress relaxation. Here information is gained by removing metal around a weld and observing the resulting strain changes in the specimen (by means of strain gages, X-rays, or photoelastic coatings, for example). The observed strains are then related to residual stresses by Hooke's law.[15] The results obtained in these experiments vary widely since straining is a strong function of the amount and distribution of metal removed--a parameter which often varies from one investigation to the next. The most serious limitation, however, is the fact that these techniques record only the cummulative, residual effects of the weld process and provide no direct measurement of the transient stress-strain development.

There have been attempts to obtain dynamic as well as residual measurements of metal movement during welding, but until quite recently the results have been only qualitative and indirect. The use of laser interferometry has appeared promising but nothing has been published on it as yet. In 1964, R. E. Travis and others obtained some useful indirect data by cementing electric-resistance strain gages on a

C-shaped constraining bar and then depositing welds on small specimens clamped between the jaws of the bar.[16] Perhaps the first truly direct data on transient weld stresses were recorded by Wilson and Corderoy in Australia in 1967.[17] In this case, thermocouples and electric-resistance strain gages were cemented on large, one-inch thick steel plates. The gages were arranged to provide both transverse and longitudinal readings at various distances from the weld line. The transient stress-strain response of the plate was then recorded during single-pass butt welds. By comparing their results with Tall's theoretical analysis,[13] the authors were able to conclude that at least qualitative verification exists.

Transient data has also been obtained in Russia utilizing pneumatic tensile strain gages. Kasatkin and others measured the movement of a selected point in the weld heat-affected zone as up to four weld beads were deposited consecutively on a small 1/4 inch iron specimen.[18] They confirmed the Wilson-Corderoy results as well as obtaining important information on multi-pass effects. In a later series of experiments these same investigators obtained longitudinal stress-strain measurements by placing pneumatic gages on a larger plate (4 x 24 inches) at various distances from a single-pass edge weld.[19] Comparison with theoretical computations again produced reasonable agreement.

As part of the NASA study at M.I.T., Masubuchi and his co-workers attempted to verify their analytical results by

using electric-resistance strain gages to measure strain changes during bead-on-plate welding of 1/4-inch, 2219 aluminum plates.[14] Here, thermocouples and three-element strain rosettes were mounted on 18 by 30 inch plates in much the same manner as the Wilson-Corderoy experiments. Readings were taken during the passage of the welding arc and continued until complete cool-down of the specimen. The most important results of the investigation were as follows:

1. In general, longitudinal strains (along the axis of the weld) were predominant. Transverse and shear strains were of smaller magnitude except in the immediate area of the live welding arc. For this reason the one-dimensional computer predictions were essentially verified.
2. Heat input significantly affected the extent of the tensile residual stress zone.
3. High compressive stresses occurred in areas ahead of the moving arc.

Concurrent with the NASA study, a similar investigation on 1/4-inch low carbon (mild) steel and HY-80 steel plates was undertaken by Klein and Maclin at the Portsmouth Naval Shipyard in New Hampshire.[20] The results corraborated Masubuchi's aluminum experiments. (The Portsmouth data has been re-analyzed and appended to this report.)

D. Aim and Purpose of the Present Study

The scientific information gained in previous investigations has certainly been important. It now appears possible, however, to make more practical use of these experimental techniques. Some of the computer models, though admittedly simplified, might be proven applicable to production methods currently in operation. The aim of this study is to take a step in that direction. The need for such an effort in the shipbuilding industry has already been established. With this in mind, an approach to the problem of measuring dynamic thermal strains in production welds applicable to marine structures was initiated.

Of the techniques discussed previously, the use of electric-resistance thermocouples and three-element strain rosettes appeared most promising. This method allows for temperature compensation of the gages and also provides enough data to determine principle as well as longitudinal and transverse strains at selected points in the weldment. When applied to ship-production welds, however, a serious problem arises. Ship and submarine fabrication most often means relatively thick-section, multi-pass welds. A meaningful investigation of any scope would thus entail a large number of passes and therefore produce an enormous amount of raw data. Since no automatic data reduction system was reported in any of the previous investigations, the development of one became an immediate primary aim of this study.

It became apparent that once a strain measurement technique and a computer data analysis program were developed, several opportunities could be exploited to advance the state of the art. In addition to testing the practical application of current theoretical weld models, the effects of thin vs thick section plates could be examined, and the controversial subject of base-plate strength-effect explored. The latter problem, that of determining the level and distributions of stresses and strains in plates of increasing strength, has been the subject of considerable comment--especially since the introduction of ultra high-strength marine steels. Up to now, results of post-weld stress relaxation measurements have raised as many questions in this regard as they have answered.

In summary, the primary purpose of this investigation is to obtain transient and residual strain-temperature data on production-type steel weldments applicable to marine structures. Objectives coincident to the data collection and reduction are:

1. to test the applicability of the NASA one-dimensional weld analyses to practical ship structural weldments.
2. to determine the effect of increasing base-plate strength on weld stress-strain distributions.
3. to determine the effect of welds on thin vs thick section plates

4. to provide information for the development of more advanced (or more practical) computer programs to calculate temperature, strain and distortion changes during welding
5. to provide an inexpensive computer program capable of translating recorded thermocouple and strain gage rosette outputs into accurate temperature and two-dimensional strain readings
6. to examine the reliability and accuracy of very high temperature (HT) strain gages mounted close to the weld line.

II PROCEDURES

A. Scope of the Research

A series of three experiments measuring strain and temperature changes during welding was performed. System models representing constrained butt joints typical of ship and submarine fabrication were constructed from rolled steel plates. The steels selected varied in strength from 80- to 180-ksi and were of grades either used or intended for use in marine structures. Welding procedures followed U. S. Navy specifications as closely as possible, consistant with the equipment available in the M.I.T. Materials Joining Laboratory.

The Portsmouth data appended to this study broadens the scope to include bead-on-plate welds of thin-section 30- and 80-ksi steels.

B. Selection of Parameters

The steels selected for this investigation were HY-80 (yield strength, 80 ksi), HY-130 (140 ksi), and an experimental maraging-type nickel steel strengthened to 180 ksi. HY-80 is a quenched-and-tempered steel and has been used extensively in modern submarine construction as well as other specialized marine applications. It derives its strength during the quenching process from the formation of highly strained bainite and martensite. Some of the strain

is relieved by tempering which provides toughness and ductility at the expense of a moderate decrease in strength. HY-130 is also a quenched-and-tempered steel with a microstructure of tempered bainite and martensite. It was developed expressly for submarine applications and was used to fabricate pressure hulls for the U. S. Navy's Deep Submergence Rescue Vehicle. It is the product of a highly sophisticated manufacturing process and represents the upper strength limit for quenched-and-tempered marine steels. The 180-ksi maraging steel represents the next generation of "Ultra-service" steels designed to provide the high strength-to-weight ratio required for deep submergence applications. Its additional strength results primarily from the precipitation of various intermetallic compounds during aging of the basic martensitic microstructure. Together with the low-strength mild steel used in the Portsmouth experiments, these materials cover the spectrum of modern hydrospace steels.

The plate thicknesses used in this study were determined by availability, ease of handling, and applicability to normal end use. End use dictates thick sections. Service thicknesses for high strength steels range from 1/2 to 3 inches. Sections much in excess of one inch, however, were deemed impractical for experimental purposes. The range of 3/4 to 1 1/4 inches was thus chosen as most representative of thick section characteristics. This range provides the heat flow characteristics, constraint, multiple passes, and joint geometry typical of

normal end use. The precise thickness of each specimen within this range was determined solely by availability.

The joint design used in this experiment (double-bevel with backing plate) was selected because it is fairly common for the thickness and process utilized. It allows welding from one side of the plate only--an important feature in view of the instrumentation attached to the plate.

The level of constraint was designed to model a submarine hull or bulkhead butt joint. The specimen was clamped at its edges to a 1/2-inch mild steel bed plate which resists deformation, but does not preclude it any more than a between-frame span of shell plating.

The size of the test plates was set at a nominal 18 by 30 inches (after joint fit-up) to provide essentially steady state conditions at strain gage locations. The 180-ksi plate was considerably smaller simply because a larger piece was not available.

The weld process used was semi-automatic Gas Metal-Arc (GMA or MIG). This process is normally prescribed for the ultra-high-strength steels and is not uncommon with HY-80. It allows excellent control of weld variables, reduces operator error, and fosters repeatability. Preheating of joints was accomplished by acetylene torches because electric strip-heaters were unavailable.

C. Strain Measurement by Electric Resistance Strain Gages

The fundamental concept of strain gage operation is that certain conductors exhibit a change in electrical resistance with a change in strain. Gages designed according to this principle are attached to test materials whose strains are then monitored by measuring resistance variations across the gage. In the case of welding thermal strains, the observed resistance change, ΔR, is made up of:

$$\Delta R = \Delta R_1(\varepsilon_e) + \Delta R_2(\varepsilon_p) + \Delta R_3(\alpha T) + \Delta R_4(T)$$

where

$\Delta R_1(\varepsilon_e)$ = the resistance change corresponding to elastic mechanical strain, ε_e, from which stresses can be computed.

$\Delta R_2(\varepsilon_p)$ = the resistance change corresponding to plastic mechanical strain, ε_p, if it exists.

$\Delta R_3(\alpha T)$ = the resistance change corresponding to temperature induced thermal strain, αT.

$\Delta R_4(T)$ = the resistance change caused by thermo-electric effects in the gage itself.

While it is not presently possible to discriminate between the two mechanical strains, ε_e and ε_p, $\Delta R_3(\alpha T)$ and $\Delta R_4(T)$ can be separated out by empirical calculation. For this purpose, a test gage of the type and lot used in the experiment is mounted on a small sample of the base plate. The sample is then heated at equilibrium until a curve of

"Apparent Strain" (R_3 + R_4) vs temperature is obtained for the operating temperature range. The gage readings recorded in the weld experiments can then be corrected by subtracting out the apparent strain value corresponding to temperatures observed at the gage location.

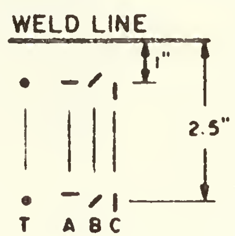
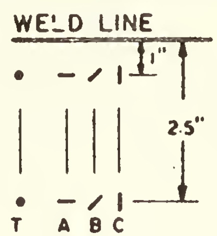
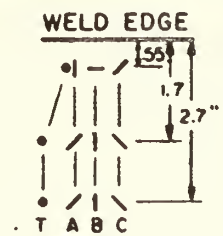
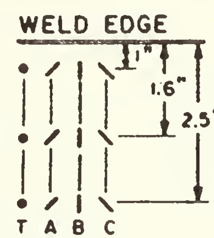
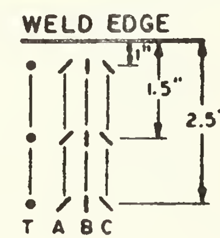
Strain gages manufactured in the form of rosettes provide as many as three independent readings in three directions at a single location. This is enough to completely describe the two dimensional strain state at that location.[15,21,22,23]

D. Description of Apparatus

1. Test Plates. A description of the test specimens is summarized in Table I. Plate dimensions and gage locations refer to Figure 2. The arrangement of constraining clamps is shown in Figure 3. The room temperature material properties of the test plate are as follows:

Material	Tensile Strength psi	0.2% Yield Strength psi	Young's Modulus psi
Mild Steel	58,000	32,000	29.3×10^6
HY-80	104,000	84,000	29.3×10^6
HY-130	147,000	156,000	28.5×10^6
180-ksi	182,000	205,000	27.5×10^6

TABLE I. TEST PLATE GEOMETRY AND SENSOR LOCATION

TEST PLATE	MILD STEEL*	HY-80*	HY-80	HY-130	180-ksi
LENGTH (in)	30	30	30	30	15
WIDTH (in)	18	18	18	18	16
THICKNESS (in)	0.25	0.25	0.75	0.75	1.0
BEVEL ANGLE	NONE	NONE	60°	45°	60°
ROOT GAP (in)	NONE	NONE	3/16	3/16	3/16
BACKING PLATE	NONE	NONE	1/4-in. HY-80	1/4-in. HY-80	1/4-in. HY-80
CONSTRAINT	TACKED	TACKED	CLAMPED	CLAMPED	CLAMPED
SENSOR LOCATION AND ORIENTATION**					

* These experiments were performed at Portsmouth.[20]

** T=Temperature Sensors; A-B-C=Strain Gage Rosette Elements. The Mild Steel plate had a Temp. Sensor and Strain Rosette mounted on the back side of the plate, opposite the one-inch-from-weld line location.

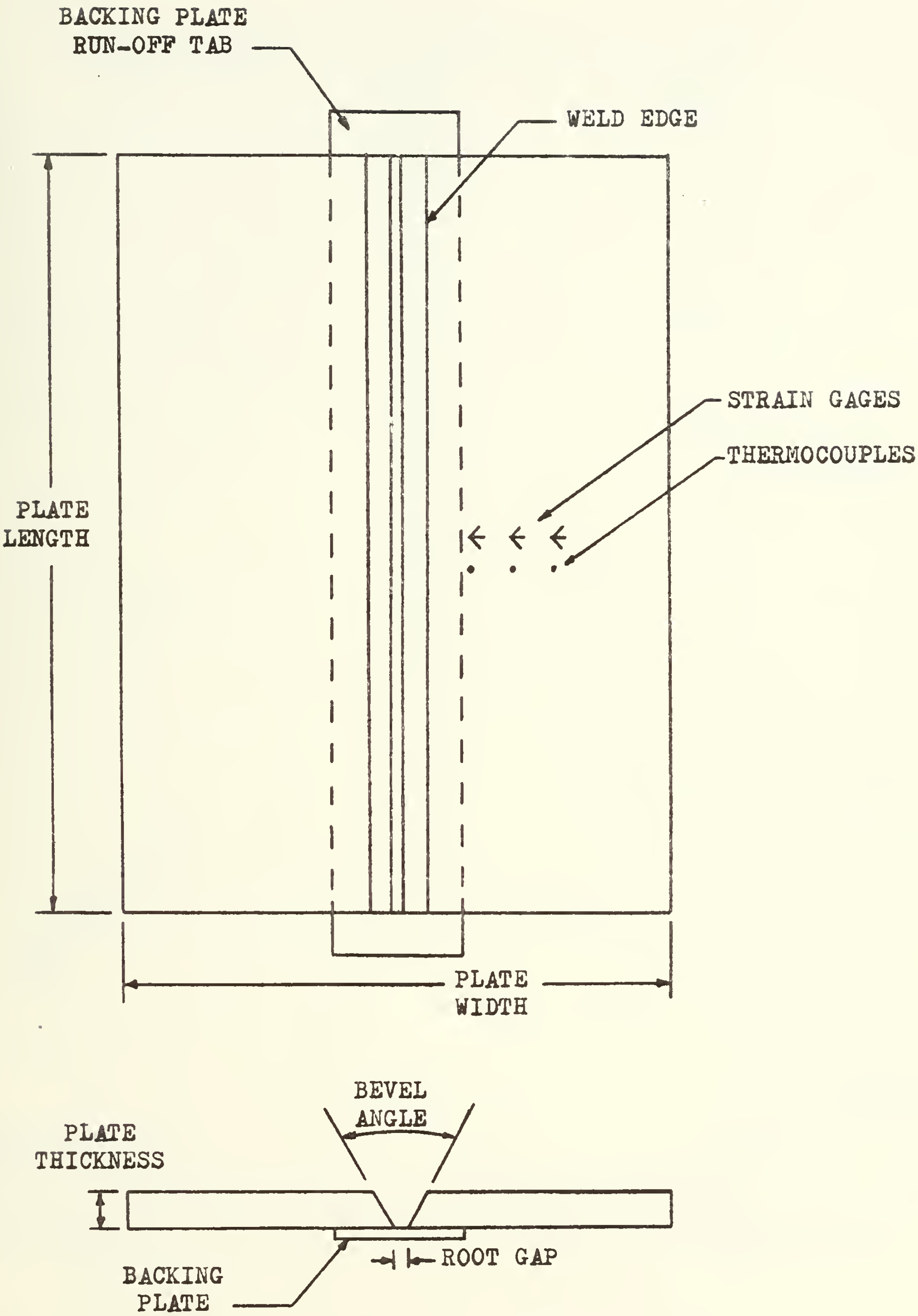


FIGURE 2. TEST PLATE AND JOINT GEOMETRY.

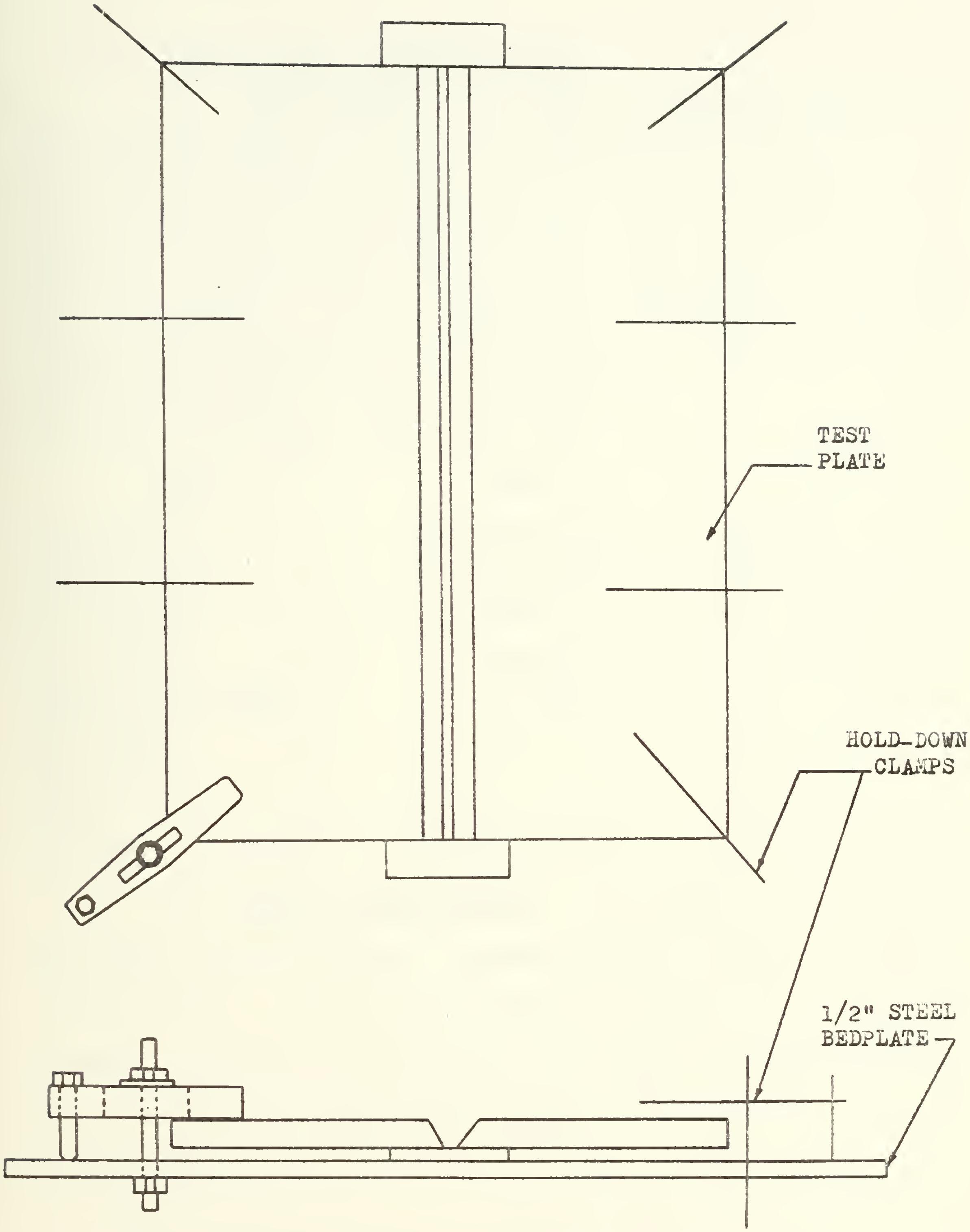


FIGURE 3. CONSTRAINING EQUIPMENT

2. Sensors and Instrumentation.

a. Strain Gages. Two types of gages were used in this investigation: SR-4 foil, 45°-rosettes; and high temperature, HT, free-filament gages. Only one set of HT gages was employed as a test of their applicability to welding experiments.* In this case three HT gages were applied in the same orientation as a 45°-rosette. All other gages were the SR-4 type. Gage properties:

Gage	SR-4	HT
Designation	FAER-25RB-12S6	HT-1212-5B
Manufacturer	BLH Electronics	BLH Electronics
Grid Length	1/4 inches	5/16 inches
Grid Width	.125 inches	3/32 inches
Temperature Range	-100 to +400 °F	-320 to +1200 °F
Resistance	120 ohms	120 ohms
Gage Factor	2.00	3.79
Cement	EPY-600	Rokide-BLH
Protective Covering	BLH Barrier-C	BLH Barrier-C

b. Temperature Sensors. All temperature sensors used were BLH Type GTM-CA (Chromel/Alumel) adhesive-bonded thermocouples. In the case of the HT gages, the thermocouple formed an integral part of one of the gages (an HT-1212-5A). In all other cases they were placed 1 1/4 inches to the left of the gages.**

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*HT gages were installed at the .55 inch-from-weld location on the 3/4-inch HY-80 plate.

**The Portsmouth experiments on mild steel and HY-80 utilized Micro-Measurements, Inc. equivalents to the BLH SR-4 and GTM-CA sensors. Alternative instrumentation and data-reduction techniques were used as required.[20]

c. Instrumentation. Strain gages were connected into a Potentiometric Circuit (Half-Wheatstone Bridge), balanced and calibrated as indicated schematically in Figure 4. Thermocouples were referenced to a 32° F ice-bath and calibrated as indicated in Figure 5. Both circuits were fed into a Honeywell continuous-recording, 12-channel Visicorder. When the raw data was actually read off the recorder tape, some traces were delayed or advanced with respect to others. This was done to correct for the finite difference in position along the weld line of the thermocouples and strain rosette elements (that is, if a thermocouple was 1 1/4 inches in front of its respective strain gage and the weld speed was .23 inches-per-second, the temperature readings were delayed 5.4 seconds with respect to the strain readings. This produces the effect of a simultaneous strain and temperature reading at the strain gage location). Timing was accomplished by means of an electric stop watch as well as a timer integral to the Visicorder.

3. Welding Equipment and Conditions. Welding conditions are summarized in Table II. The welding machine utilized was manufactured by the Linde Division of Union Carbide Corporation and consisted of a type HW-16 GMA torch, a SVI-300 power supply, and associated governor, carriage and wire feed mechanisms. Travel speed, arc voltage and amperage were preset before each pass. Arc length was adjustable during

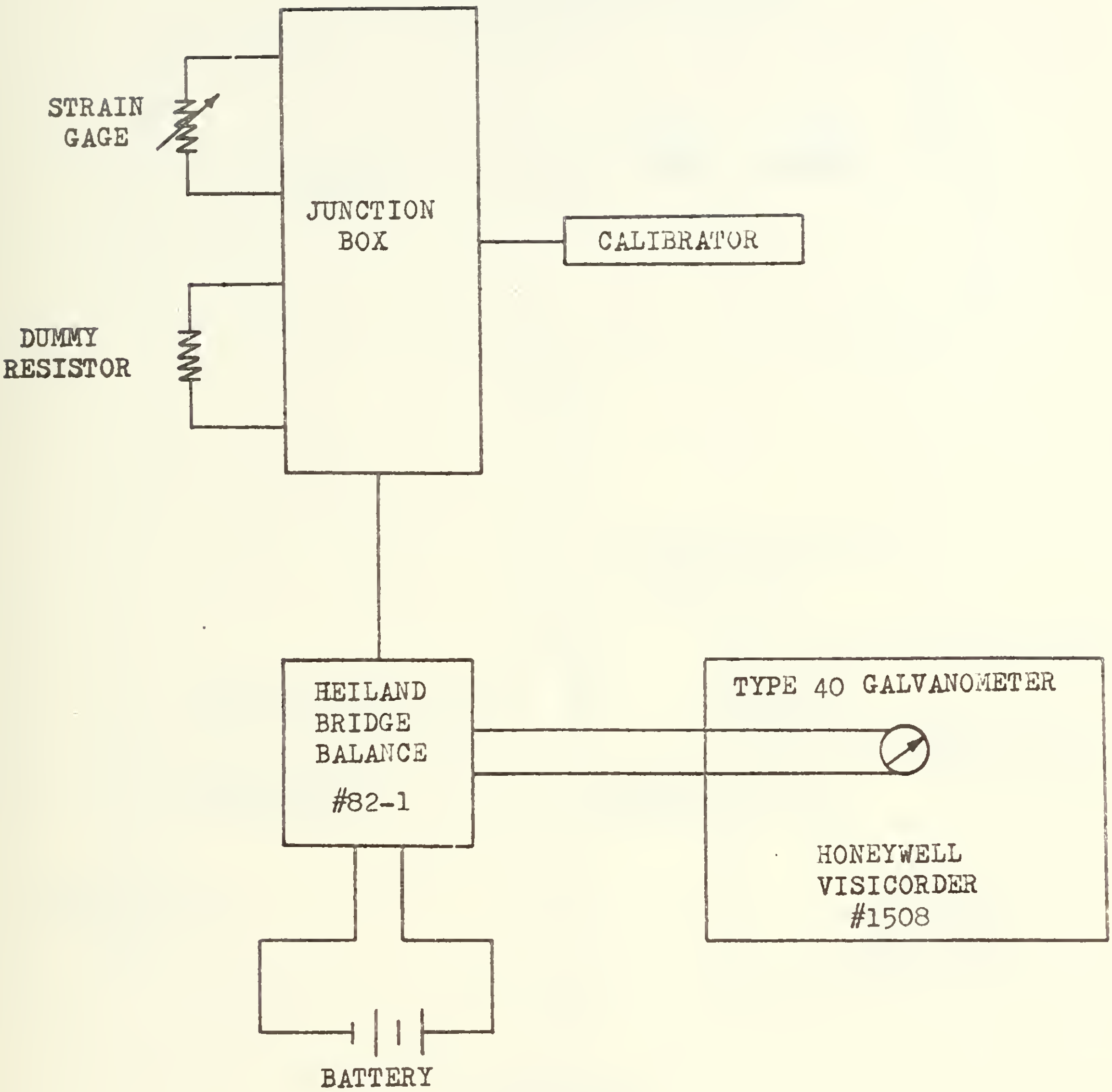


FIGURE 4. STRAIN GAGE INSTRUMENTATION CIRCUIT.

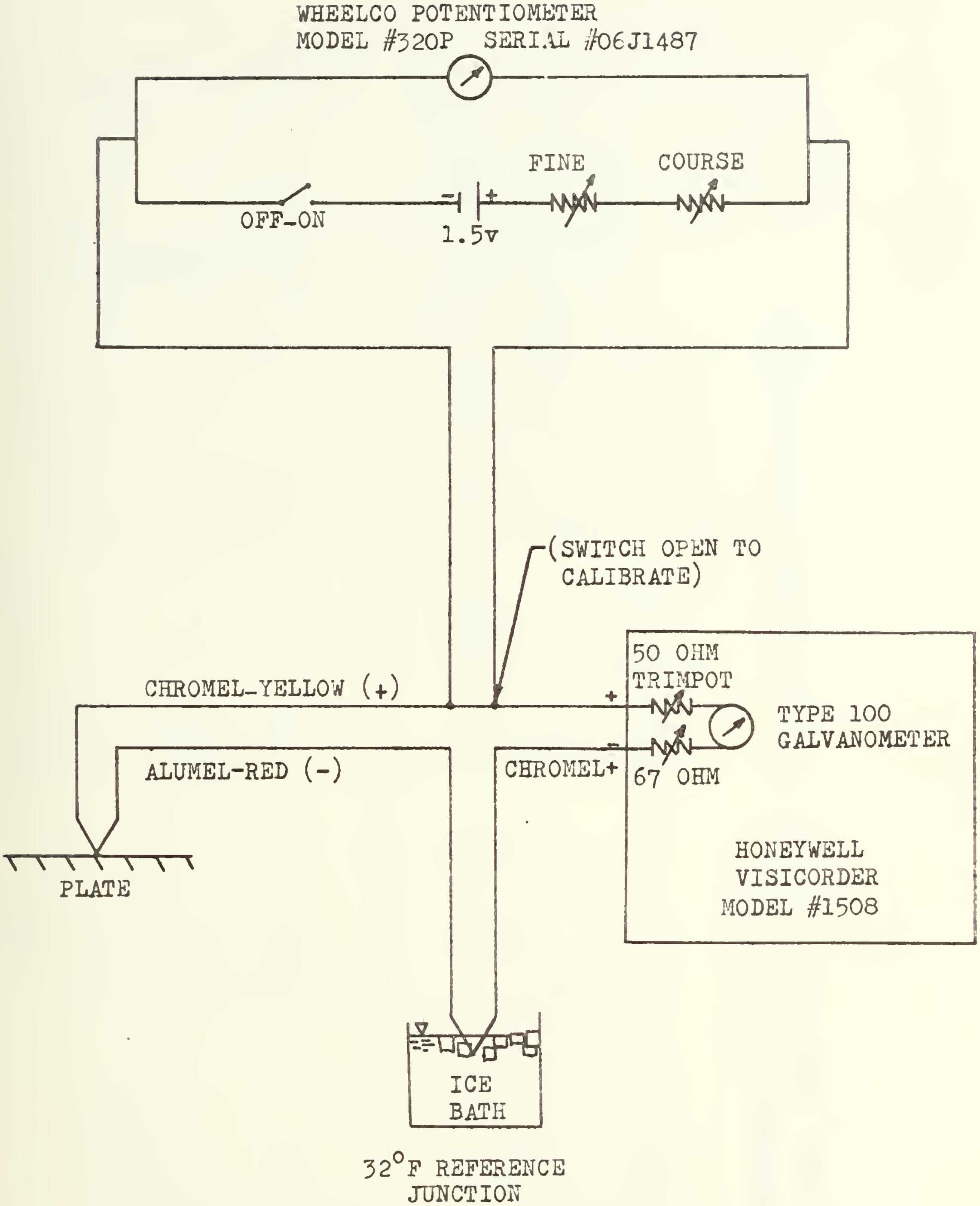


FIGURE 5. <u>THERMOCOUPLE INSTRUMENTATION CIRCUIT.</u>

TABLE II. WELDING CONDITIONS.

TEST PLATE	MILD STEEL*	HY-80*	HY-80	HY-130	180-KSI
WELD TYPE	BEAD-ON-PLATE	BEAD-ON-PLATE	BUTT	BUTT	BUTT
PROCESS	GMA	GMA	GMA	GMA	GMA
ARC VOLTS	30	30	28	28	28
POLARITY	DCRP	DCRP	DCRP	DCRP	DCRP
TRAVEL SPEED (IPM)	24	24	15,20**	14	14
HEAT INPUT (KJOULES/IN)	21	21	32,24**	35	35
FILLER WIRE	1/16" B-88	1/16" B-88	1/16" AIRCO-632	1/16" LINDE-140	1/16" LINDE-140
SHIELDING GAS	ARGON, 2% O_2	ARGON, 2% O_2	PURE ARGON	PURE ARGON	PURE ARGON
NO. PASSES	1	1	18	8	20
PRE-HEAT & INTERPASS TEMP.	$70^{o}F$	$70^{o}F$	$125-150^{o}F$	$125-150^{o}F$	$125-150^{o}F$

* EXPERIMENTS PERFORMED AT PORTSMOUTH.[20]

**TRAVEL SPEED CHANGED FROM 15 TO 20 IPM AFTER 3RD PASS TO IMPROVE WELD APPEARANCE.

the weld. Wire feed is a function of the other variables and was maintained by the machine automatically. Pre-heat was applied by acetylene torches using Linde size 30 tips. Care was taken to see that heat soaked in at least four to six inches on either side of the joint. Pre-heat and interpass temperatures were monitored by means of "Tempilstik" melting crayons as well as the installed thermocouples. Cooling between passes was aided by the application of wet rags well back from the joint. This should have approximated the heat absorption properties of a section of hull plating much larger than the 18-inch wide test specimen.

Figures 6 through 9 are photographs of the actual equipment set-up.

E. Experimental Procedures

The experimental operation is shown schematically in Figure 10. The test plate was instrumented, clamped into place and pre-heated. The welding machine was lined up with the joint and positioned over the run-off tab at the left end of the backing plate (shown in Figure 2). Welding speed, arc voltage and amperage were pre-set. The visicorder was actuated and an arc was struck on the backing plate. As the welding torch started moving down the plate, arc length was adjusted and the timer was started. The Visicorder output was marked when the arc passed the strain gage location. When the welding head reached the run-off tab at the right end of

FIGURE 6. OVERVIEW OF EXPERIMENTAL EQUIPMENT.

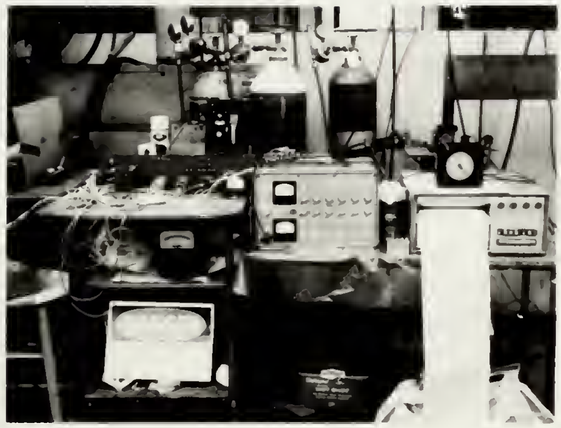


FIGURE 7. INSTRUMENTATION AND RECORDING EQUIPMENT.

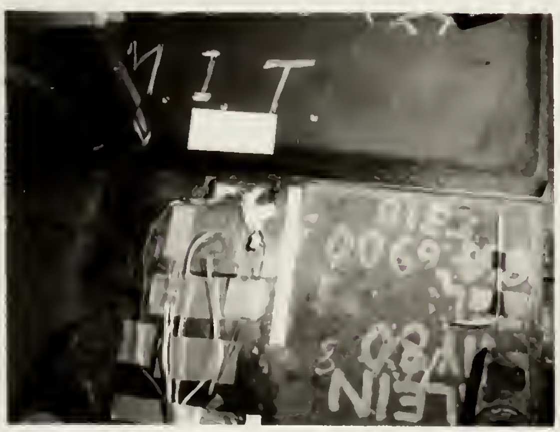


FIGURE 8. 3/4-INCH HY-80 PLATE, INSTRUMENTED AND CLAMPED UNDER WELDING TORCH.

FIGURE 9. SENSOR INSTALLATION ON 180-KSI PLATE.

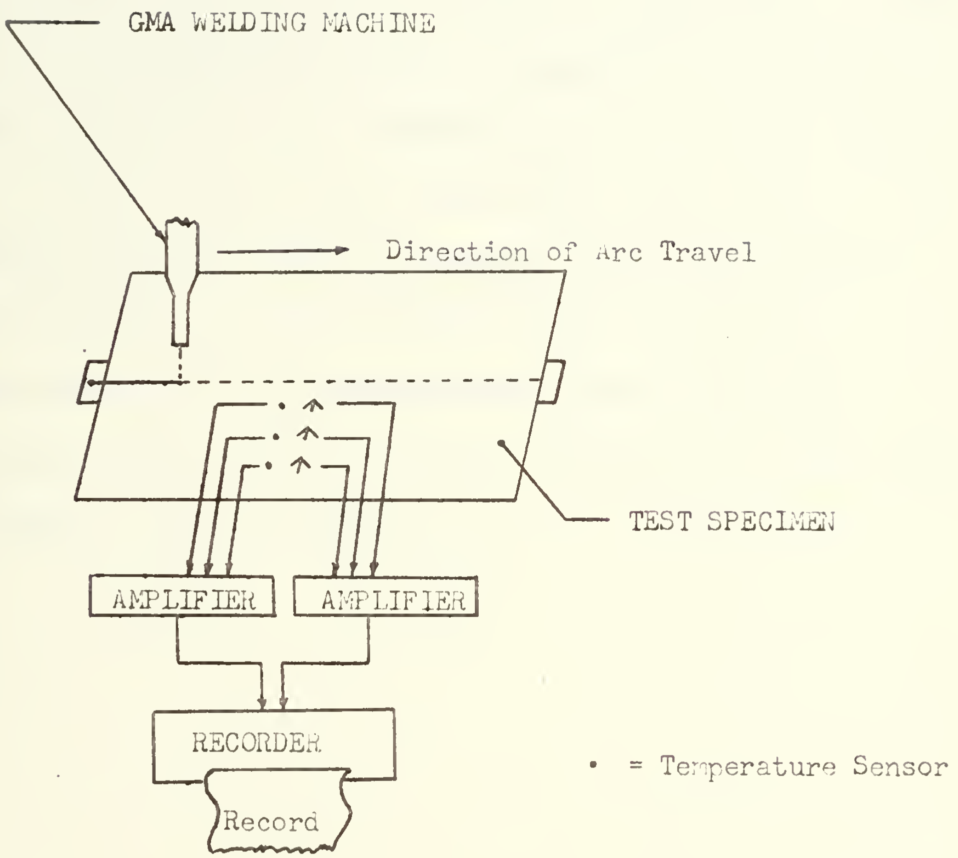


FIGURE 10. SCHEMATIC OF APPARATUS AND PROCEDURE.

the plate, the arc was extinguished and the plate allowed to cool. The recorder continued to monitor the gages for approximately three minutes (or until conditions appeared stable). Readings were then taken periodically until the plate cooled to the required interpass temperature. After cooling, the welding head was re-aligned at the left end of the plate and the process repeated until the joint was completed. After the last pass, the plate was cooled to room temperature and the clamps released while the recorder was still monitoring. On two plates, HY-80 and 180-ksi, full cool-down occurred on an intermediate pass since the job covered more than one day's work. Pre-heat was again applied at the start of the next day.

III RESULTS

The results of this investigation consist of mechanical strain data recorded during welding of test specimens. The data is presented below in the form of plots of mechanical strain and temperature vs time. A more exact presentation in table form appears in Appendix B.

A. Presentation of Data

The plots presented in this section reflect the weld history of each of the test plates. Each plot records the strain and temperature variations during one weld pass and subsequent cool-down. Not every pass is recorded. Those selected generally include the first two, the last, and other passes considered typical of the developing trend. For each plate, the final readings on the last pass represent the cummulative strain state at the gage locations.

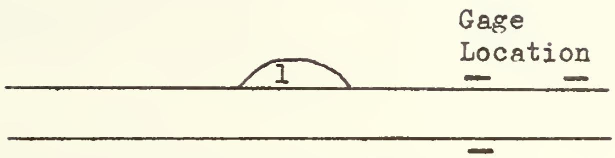
The plots are grouped according to the five test plates. The groups are preceded by schematic diagrams depicting the sequence and locations of the passes on the plate (Figures 11, 14, 17, 25, and 32). For comparison purposes, each group is also preceded by theoretical strain and temperature response curves obtained from the NASA computer model.[14] The computer solution is one-dimensional and provides only longitudinal strains. Experimental data, however, is expressed in terms of the principle strains which result from any two-dimensional

strain state. For purposes of simplification, only the maximum of the two principle strains is shown.

The plots are constructed on semilog scales. The horizontal axis is a log scale of time, expressed in seconds (see Figure 12). Zero time is arbitrary, occurring some time after the arc has stabilized and is moving down the plate toward the gage location. The point at which the arc passes this location is marked ("ARC"). The limiting time on the scale (10,000 seconds) is not meant to be taken literally, but represents a time in excess of several hours by which the plate has reached ambient (residual) conditions.

The vertical axis is a linear scale of both temperature and mechanical strain. In order to fit neatly on the same scale, both quantities are expressed in unusual terms. Temperature is plotted in Degrees, Fahrenheit, divided by 1,000 and added to 1.0. Thus, 1.250 indicates a temperature of 250° F. Mechanical strain is expressed in microstrain divided by 1,000. (Microstrain equals 10^{-6} inches-per-inch elongation.) Thus, a value of -1.0 read off the strain scale would indicate a *compressive* strain of 1,000 microstrain (1,000 micro-inches-per-inch). A value of +1.0 would be a *tensile* strain of 1,000 micro-inches-per-inch.

TEST 1: 1/4" MILD STEEL



BEAD-ON-PLATE WELD

FIGURE 11. WELDING PASS SEQUENCE.

SCALES UTILIZED IN PLOTS:

1. Horizontal.

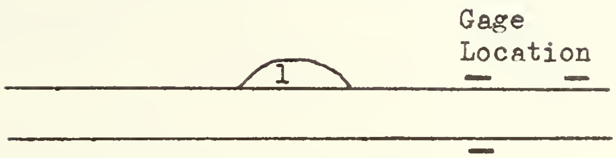
   Time = Seconds

2. Vertical.

   $$\text{Temperature} = \frac{^{\circ}F}{1{,}000} + 1.0$$

   $$\text{Mech. Strain} = \frac{\text{in/in} \times 10^{-6}}{1{,}000} = \frac{\text{microstrain}}{1{,}000}$$

TEST 1: 1/4" MILD STEEL



BEAD-ON-PLATE WELD

FIGURE 11. WELDING PASS SEQUENCE.

SCALES UTILIZED IN PLOTS:

1. Horizontal.

   Time = Seconds

2. Vertical.

   $$\text{Temperature} = \frac{{}^{\circ}F}{1{,}000} + 1.0$$

   $$\text{Mech. Strain} = \frac{\text{in/in} \times 10^{-6}}{1{,}000} = \frac{\text{microstrain}}{1{,}000}$$

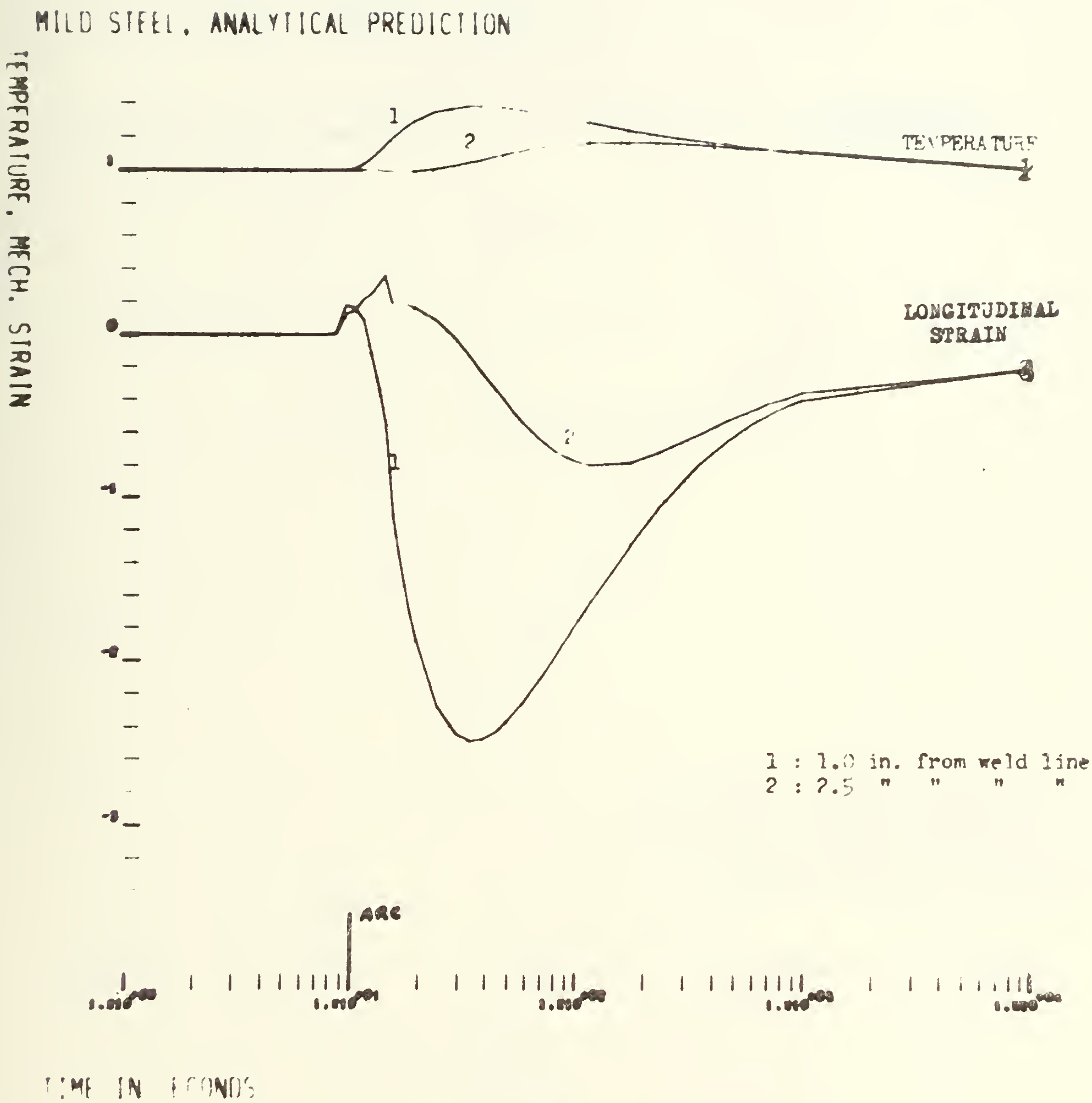

MILD STEEL, ANALYTICAL PREDICTION
TEMPERATURE, MECH. STRAIN
TEMPERATURE
LONGITUDINAL STRAIN
1 : 1.0 in. from weld line
2 : 2.5 " " " "
ARC
TIME IN SECONDS

FIGURE 12.

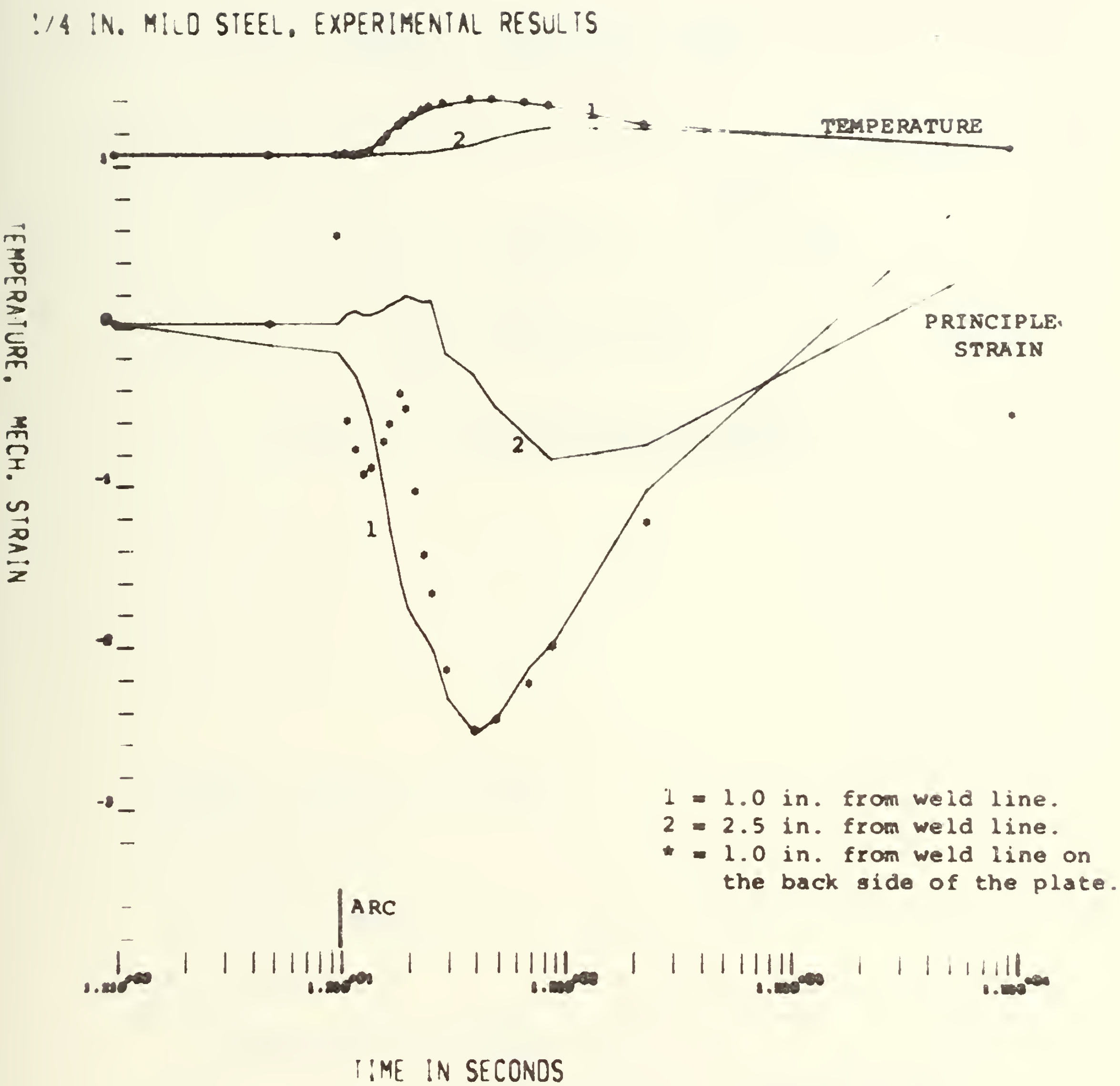
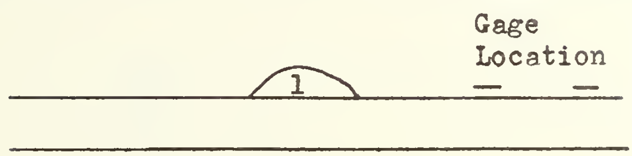

1/4 IN. MILD STEEL, EXPERIMENTAL RESULTS
TEMPERATURE
PRINCIPLE STRAIN
TEMPERATURE, MECH. STRAIN
1
2
ARC
1 = 1.0 in. from weld line.
2 = 2.5 in. from weld line.
* = 1.0 in. from weld line on the back side of the plate.
TIME IN SECONDS

FIGURE 13.

TEST 2: 1/4" HY-80 STEEL



BEAD-ON-PLATE WELD

FIGURE 14. WELDING PASS SEQUENCE.

SCALES UTILIZED IN PLOTS:

1. Horizontal.

   Time = Seconds

2. Vertical.

   $$\text{Temperature} = \frac{{}^{o}F}{1{,}000} + 1.0$$

   $$\text{Mech. Strain} = \frac{\text{in/in} \times 10^{-6}}{1{,}000} = \frac{\text{microstrain}}{1{,}000}$$

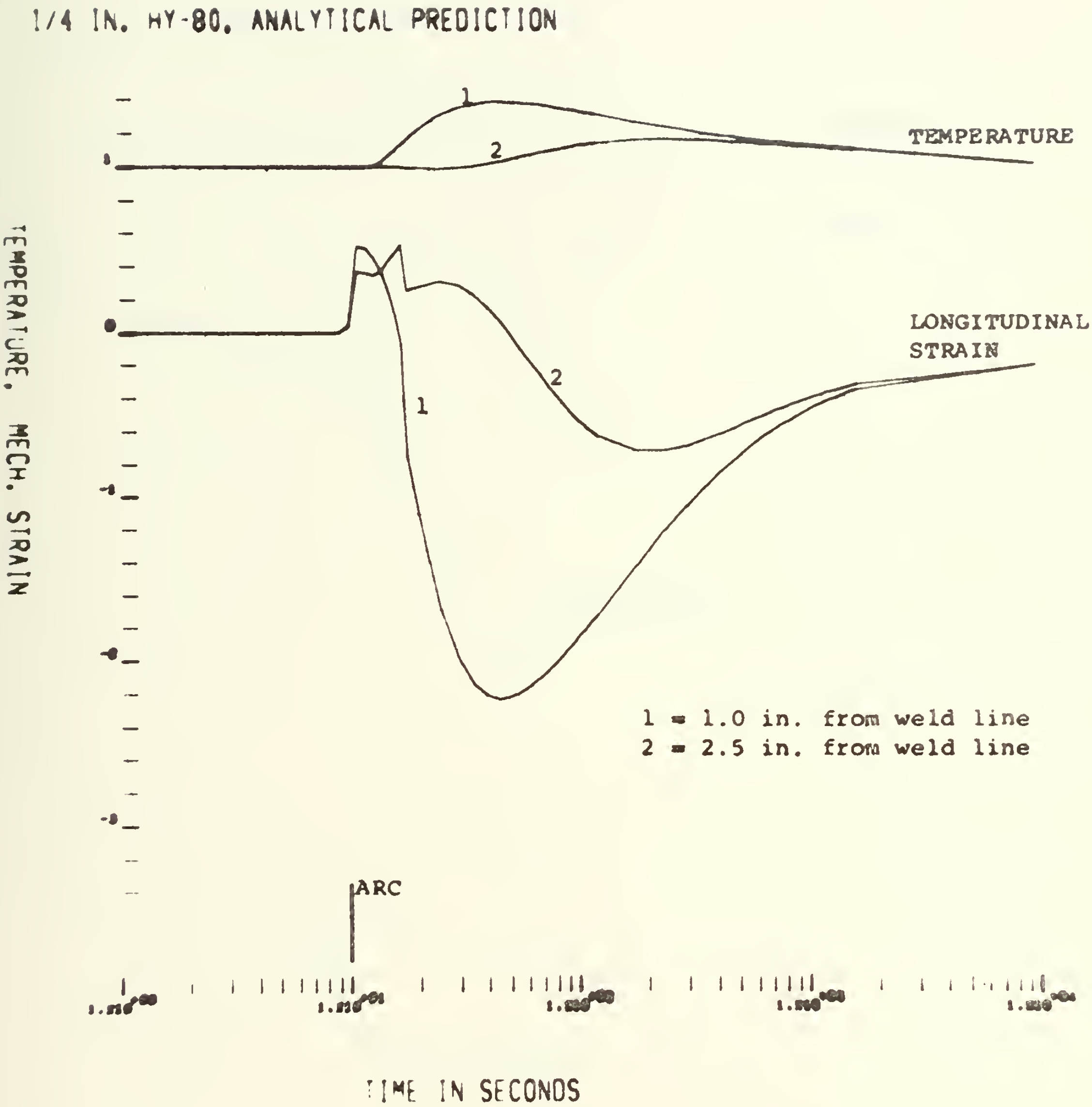
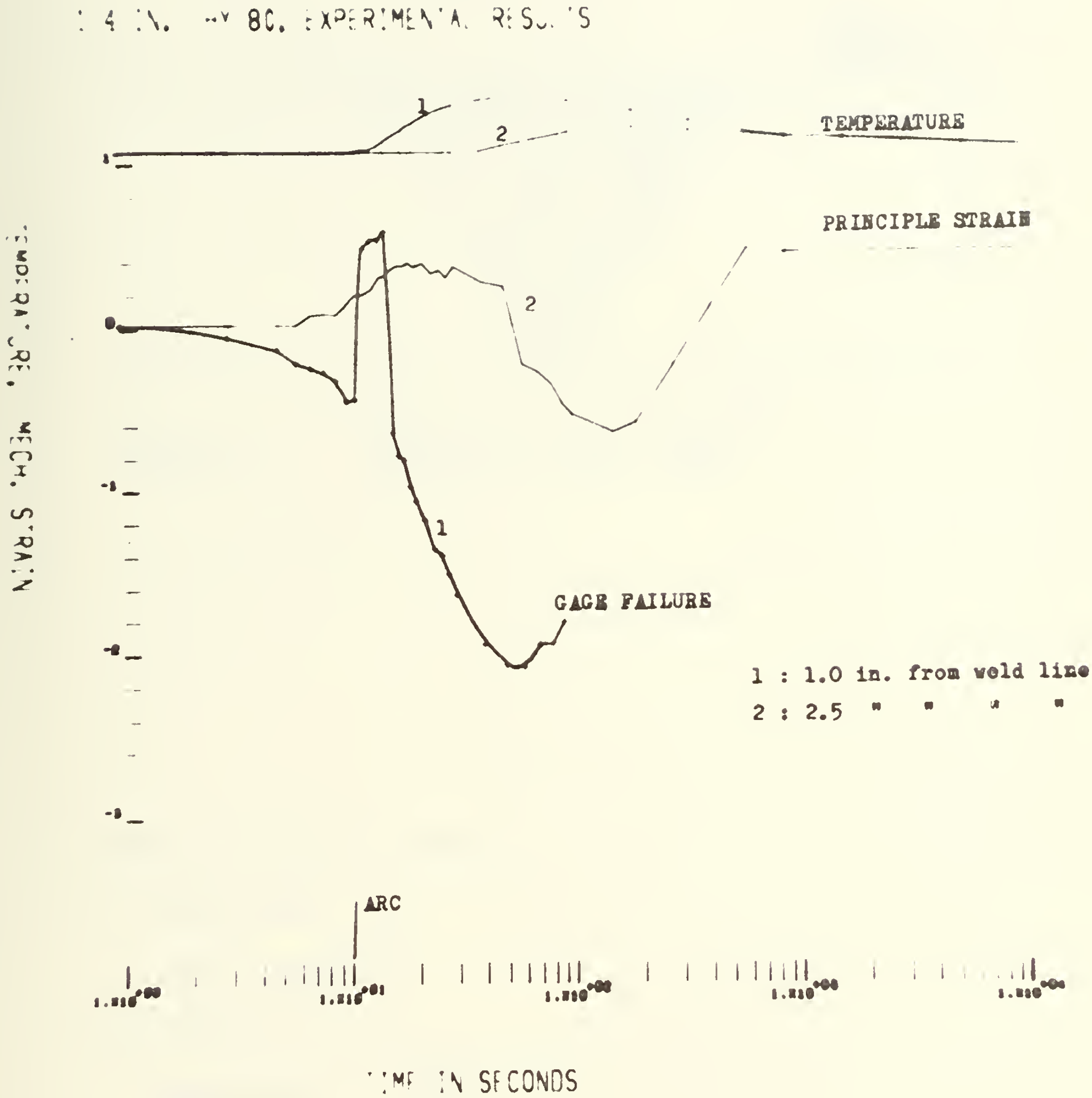

1/4 IN. HY-80, ANALYTICAL PREDICTION
TEMPERATURE
LONGITUDINAL STRAIN
1
2
TEMPERATURE, MECH. STRAIN
1 = 1.0 in. from weld line
2 = 2.5 in. from weld line
ARC
TIME IN SECONDS

FIGURE 15.



TEMPERATURE
PRINCIPLE STRAIN
GAGE FAILURE
1 : 1.0 in. from weld line
2 : 2.5 " " " "
ARC

FIGURE 16.

TEST 3: 3/4" HY-80 STEEL

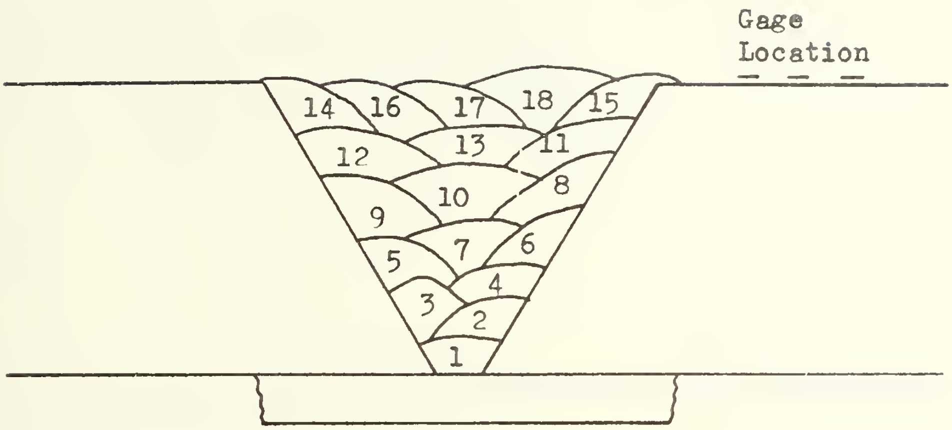


FIGURE 17. SEQUENCE OF WELD PASSES

SCALES UTILIZED IN PLOTS:

1. Horizontal.

   Time = Seconds

2. Vertical.

   $$\text{Temperature} = \frac{{}^{\circ}\text{F}}{1{,}000} + 1.0$$

   $$\text{Mech. Strain} = \frac{\text{in/in} \times 10^{-6}}{1{,}000} = \frac{\text{microstrain}}{1{,}000}$$

3/4 IN. HY-80, ANALYTICAL PREDICTION

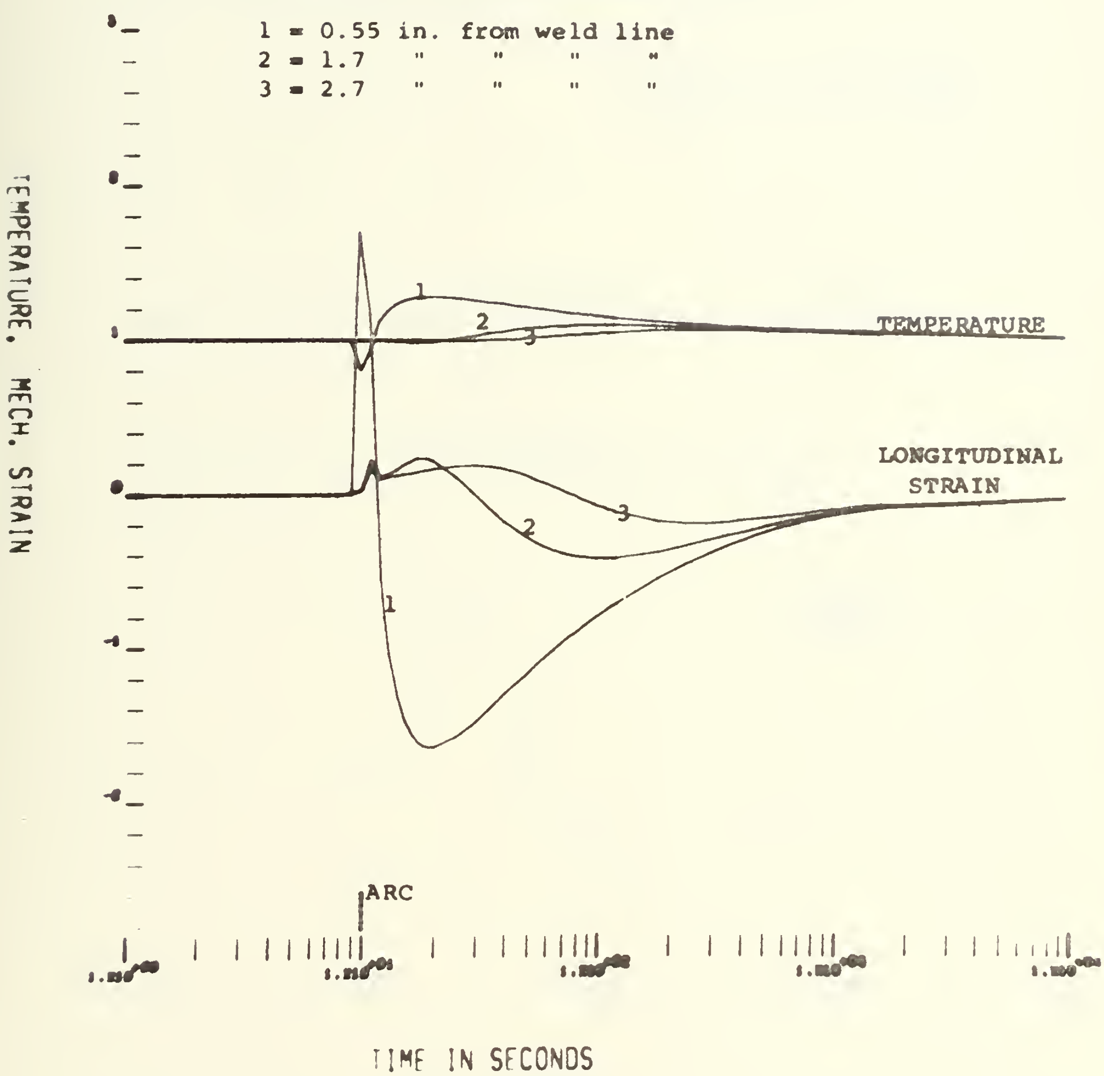


FIGURE 18.

3/4 IN. HY-80 STEEL, EXPERIMENTAL RESULTS, PASS 1

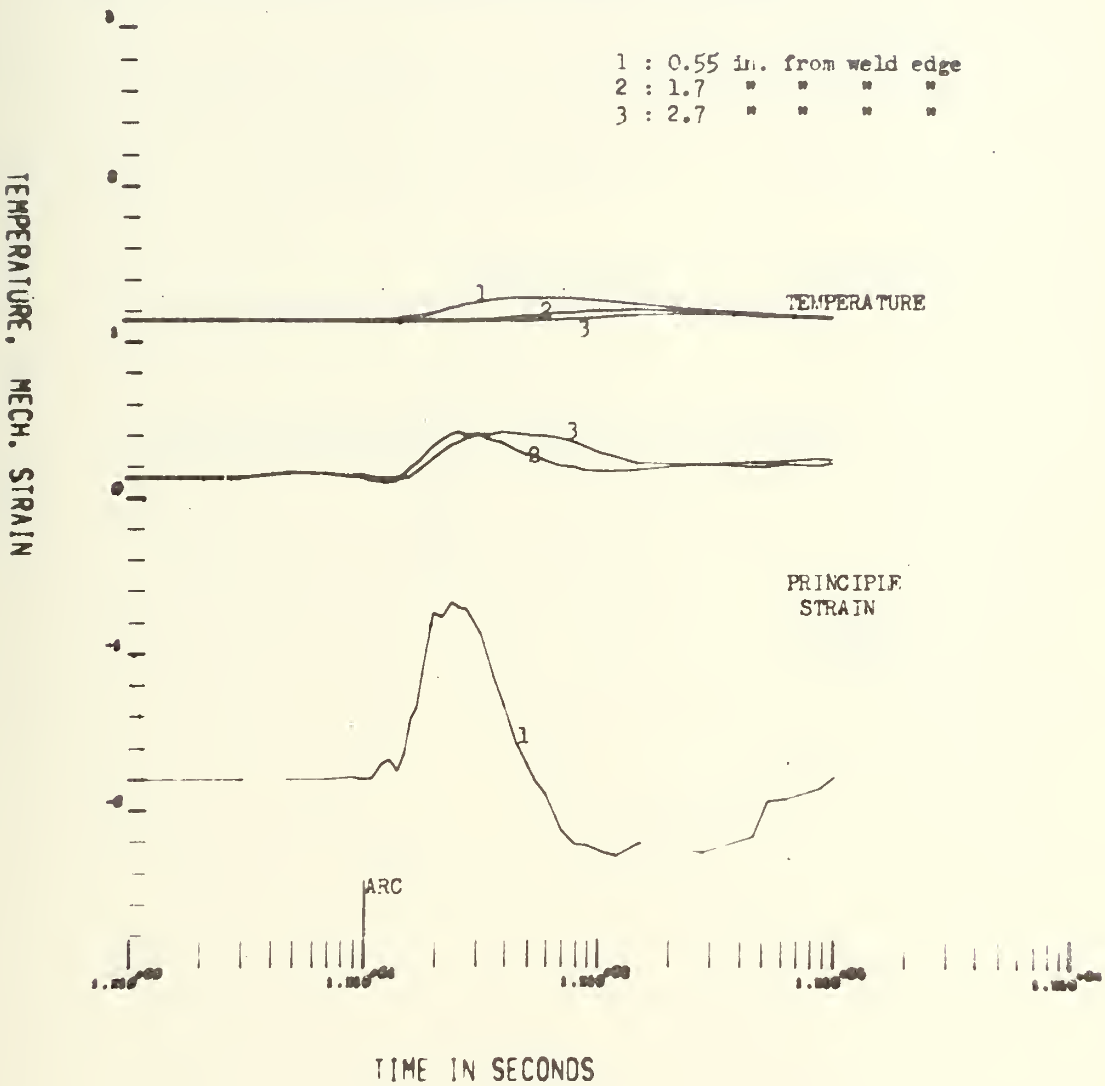


FIGURE 19.

3/4 IN. HY-80 STEEL, EXPERIMENTAL RESULTS, PASS 2

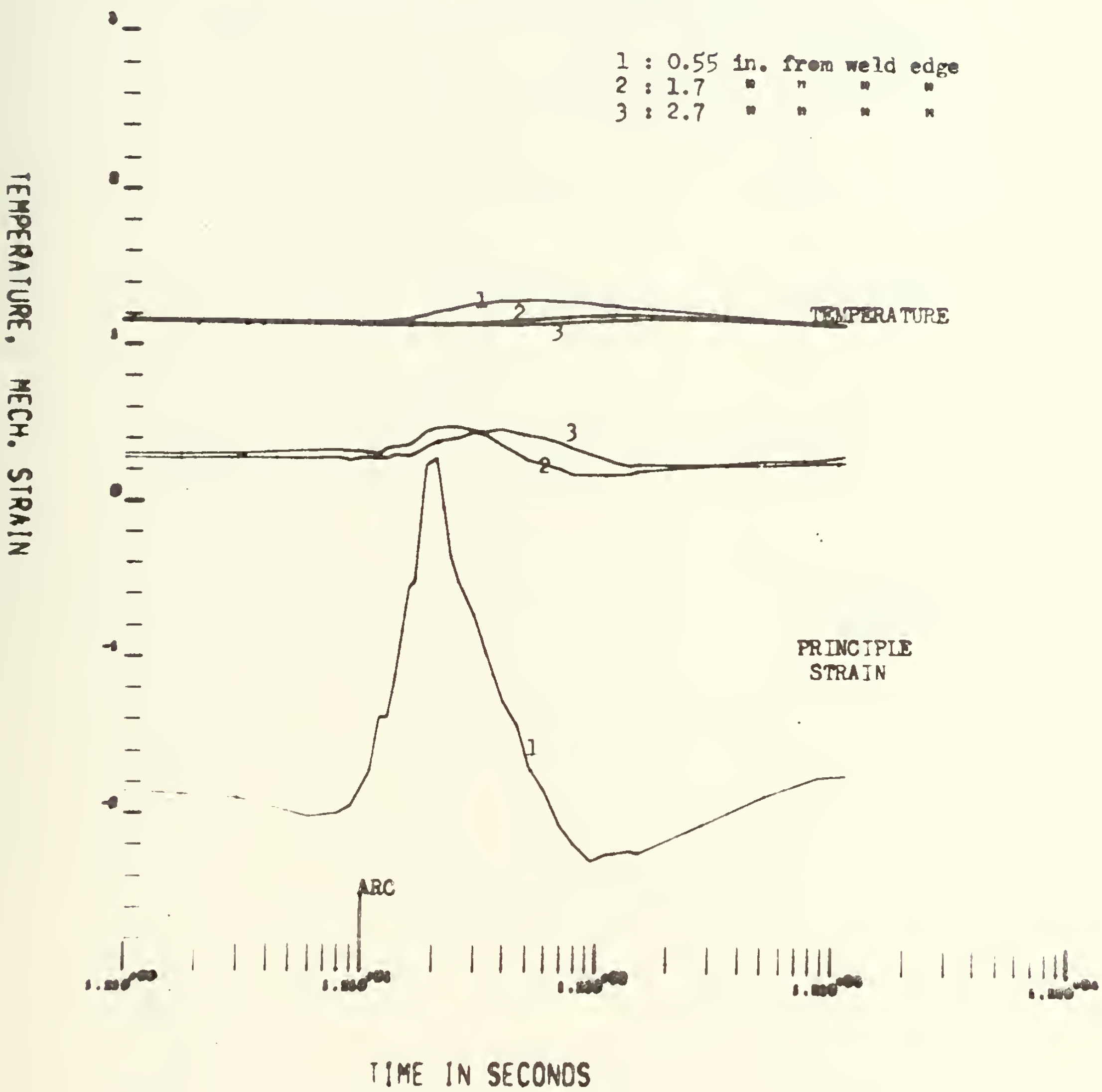


FIGURE 20.

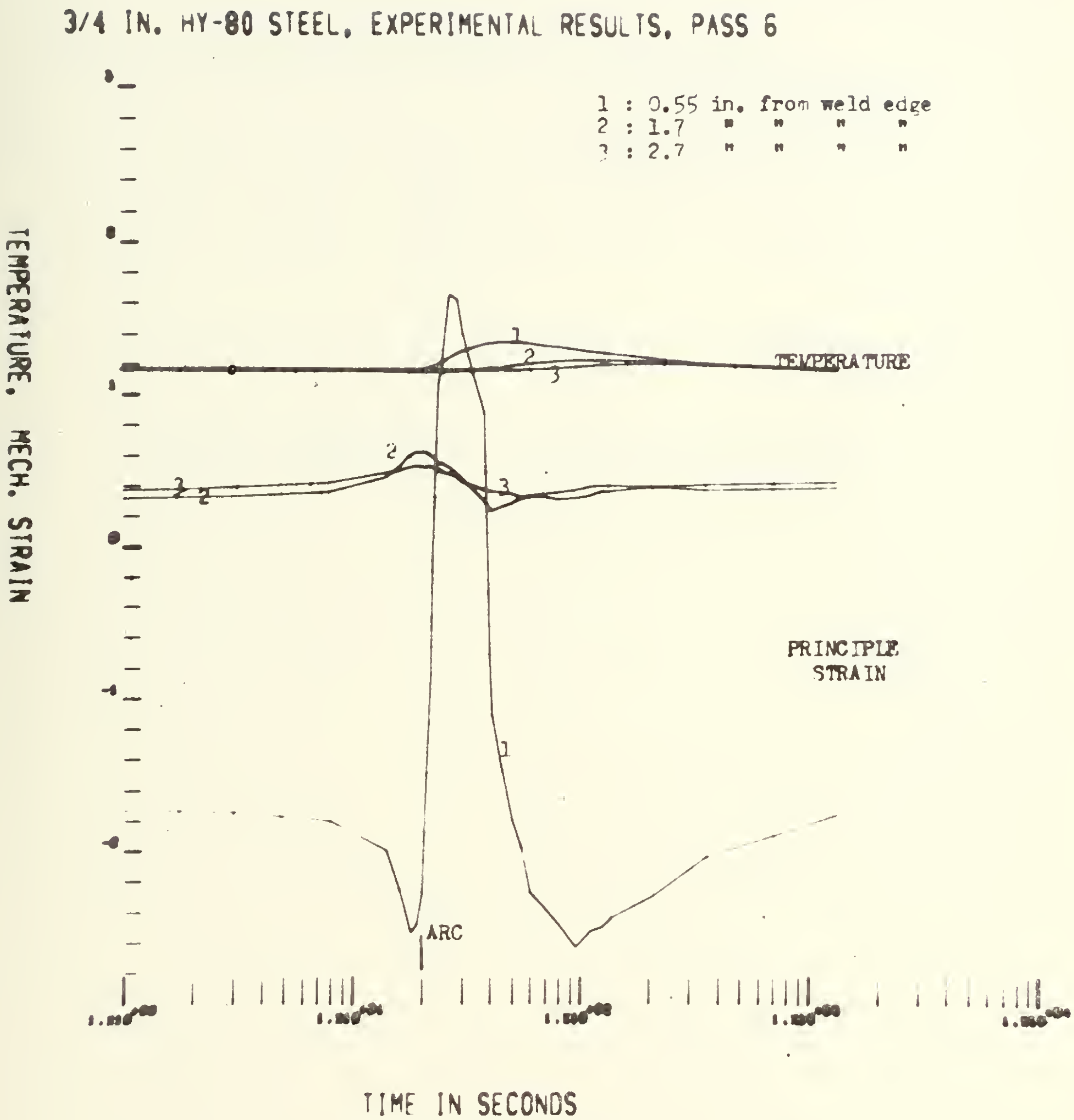

3/4 IN. HY-80 STEEL, EXPERIMENTAL RESULTS, PASS 6
1 : 0.55 in. from weld edge
2 : 1.7 " " " "
3 : 2.7 " " " "
TEMPERATURE
PRINCIPLE STRAIN
ARC
TEMPERATURE, MECH. STRAIN
TIME IN SECONDS

FIGURE 21.

3/4 IN. HY-80 STEEL, EXPERIMENTAL RESULTS, PASS 6

TIME IN SECONDS

FIGURE 31

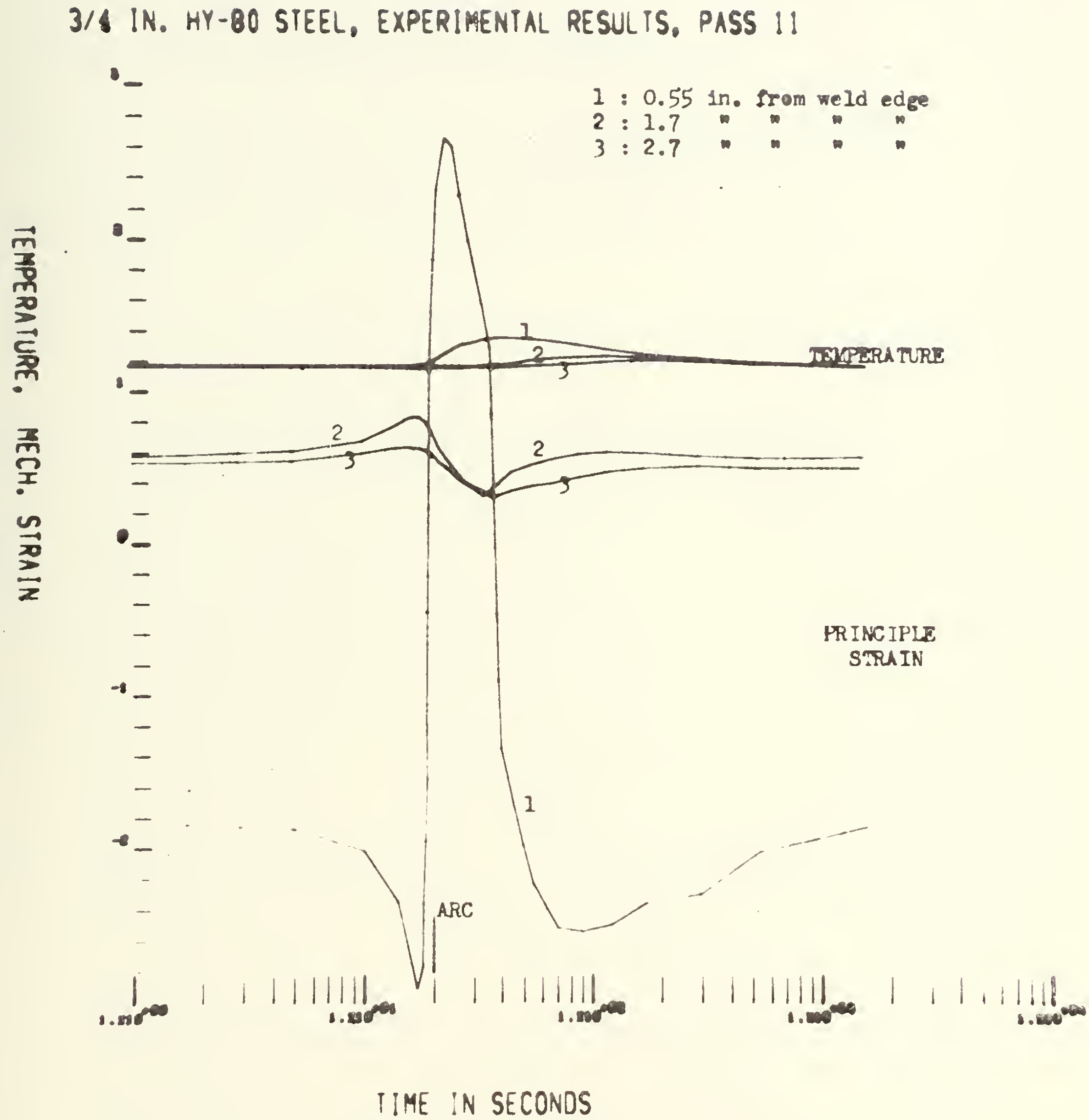

3/4 IN. HY-80 STEEL, EXPERIMENTAL RESULTS, PASS 11
1 : 0.55 in. from weld edge
2 : 1.7 " " " "
3 : 2.7 " " " "
TEMPERATURE
PRINCIPLE
STRAIN
ARC
TEMPERATURE, MECH. STRAIN
TIME IN SECONDS

FIGURE 22.

3/4 IN. HY-80 STEEL, EXPERIMENTAL RESULTS, PASS 12

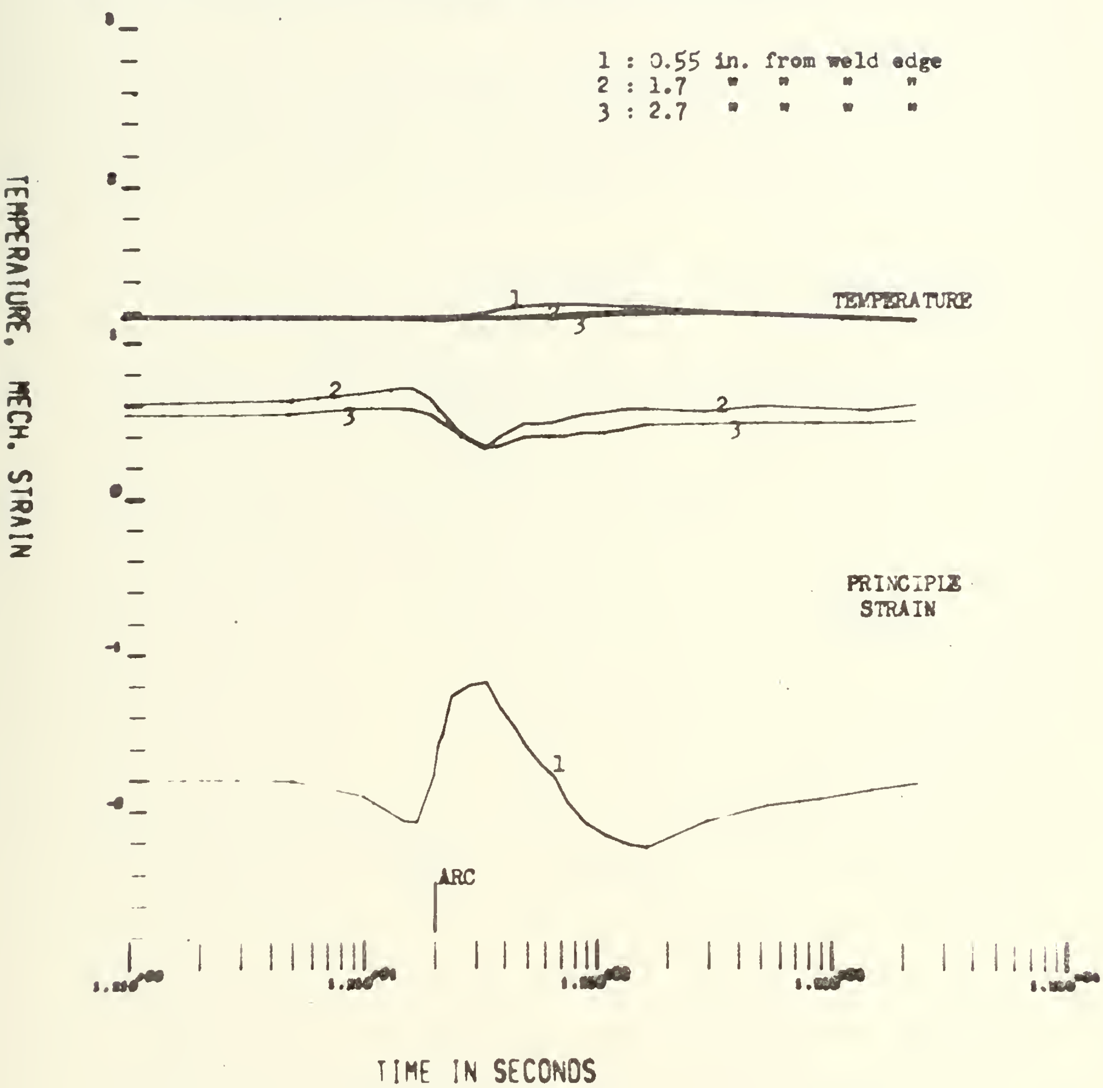


FIGURE 23.

3/4 IN. HY-80 STEEL, EXPERIMENTAL RESULTS, PASS 18

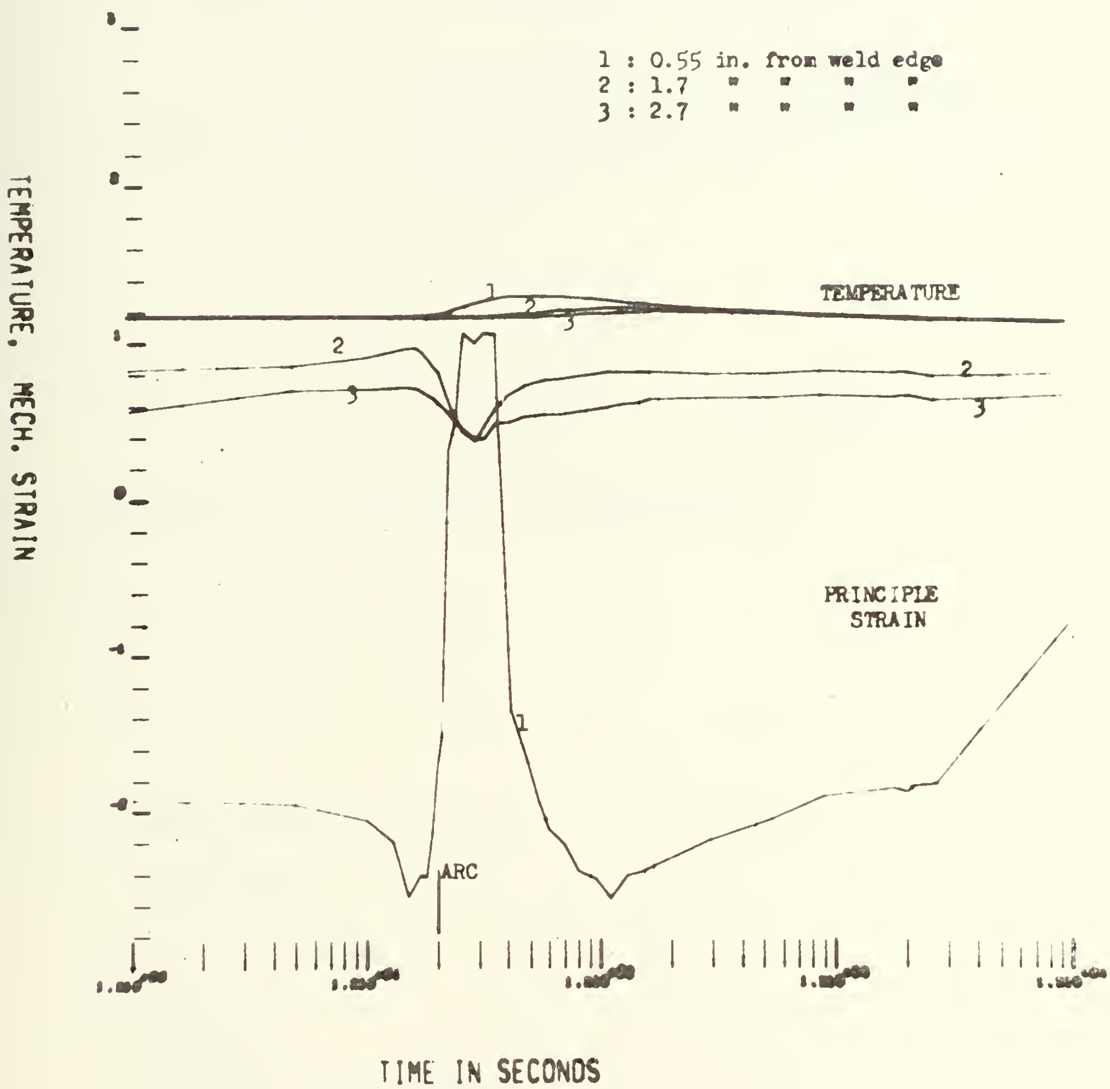


FIGURE 24.

TEST 4: HY-130 STEEL

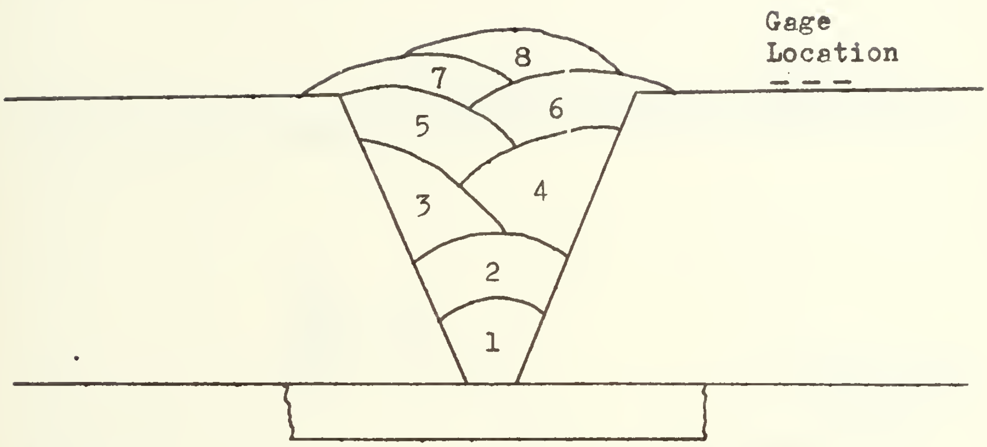


FIGURE 25. SEQUENCE OF WELD PASSES

SCALES UTILIZED IN PLOTS:

1. Horizontal.

   Time = Seconds

2. Vertical.

   Temperature $= \dfrac{^{\circ}F}{1{,}000} + 1.0$

   Mech. Strain $= \dfrac{\text{in/in} \times 10^{-6}}{1{,}000} = \dfrac{\text{microstrain}}{1{,}000}$

HY-130, ANALYTICAL PREDICTION

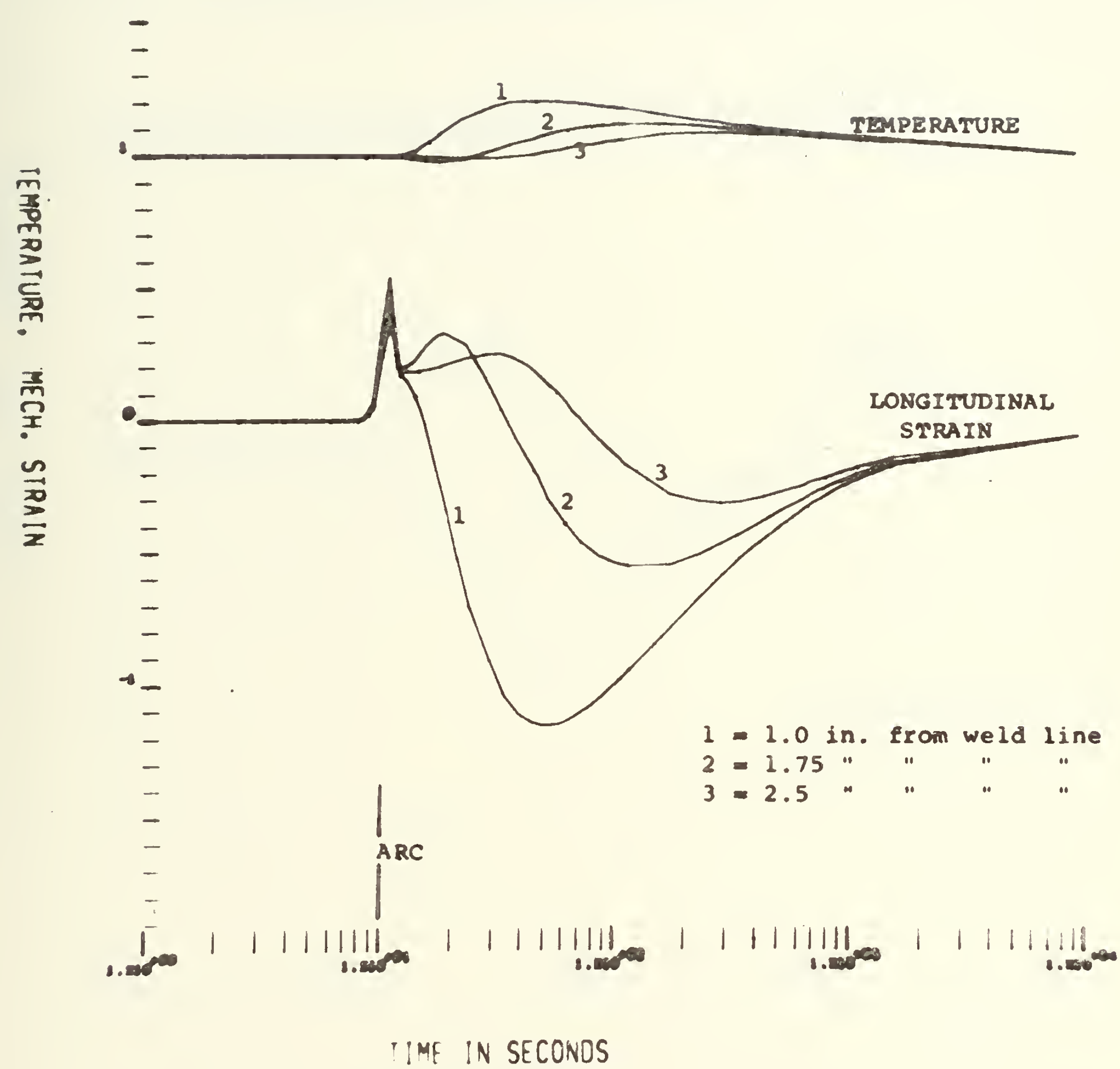


FIGURE 26.

3/4 IN. HY-130 STEEL, EXPERIMENTAL RESULTS, PASS 1

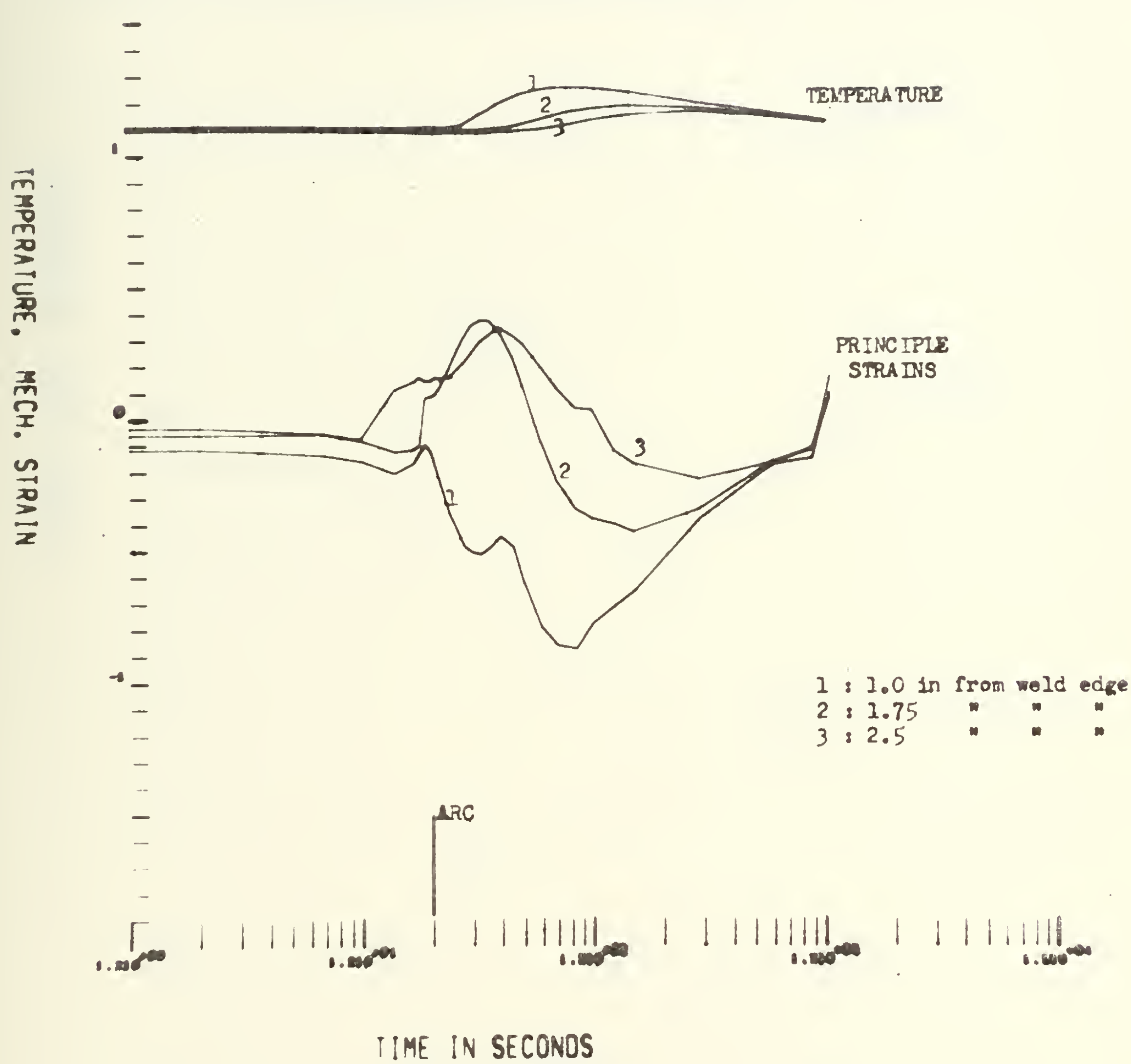


FIGURE 27.

3/4 IN. HY-130, EXPERIMENTAL RESULTS, PASS 2

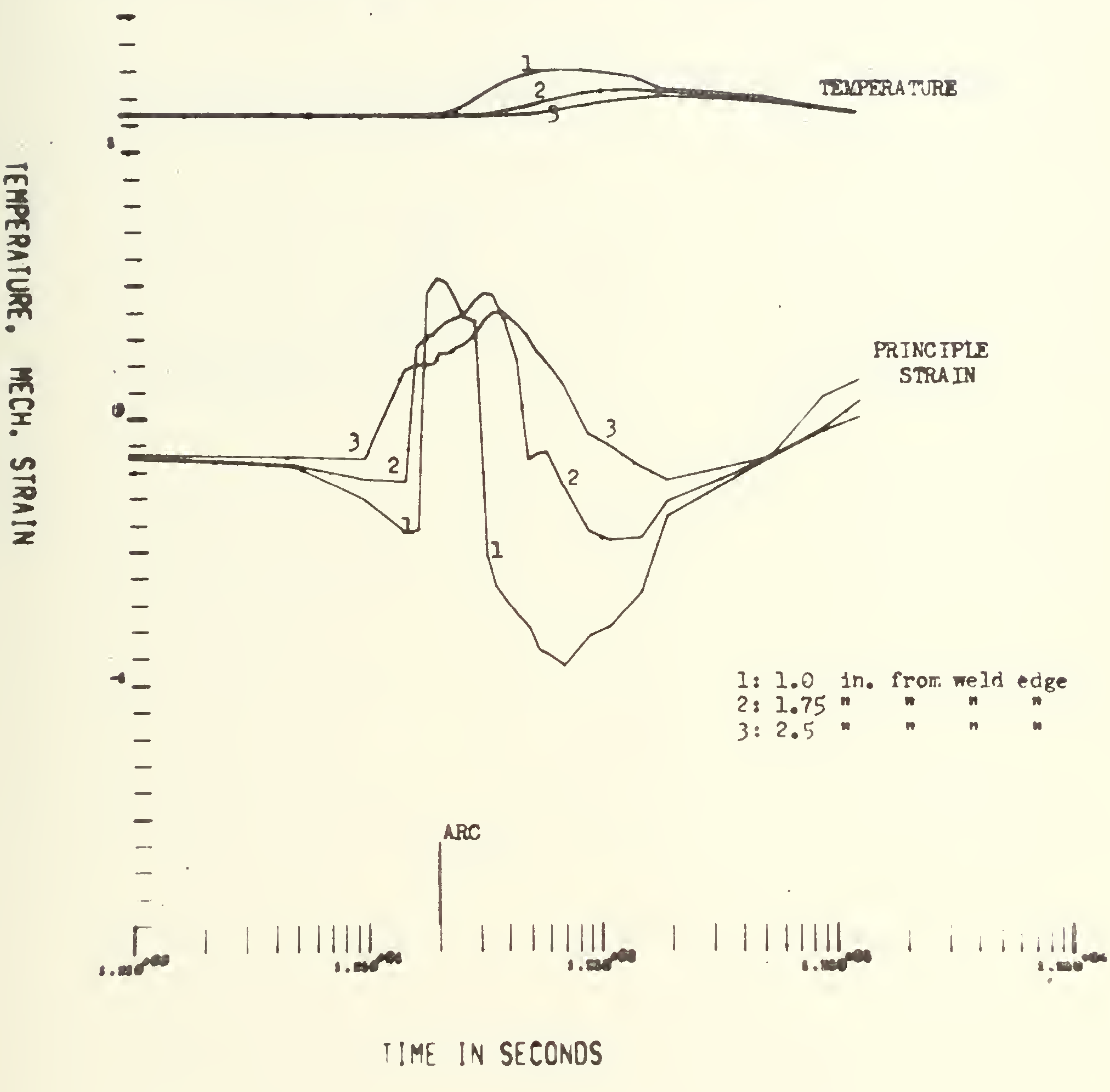


FIGURE 28.

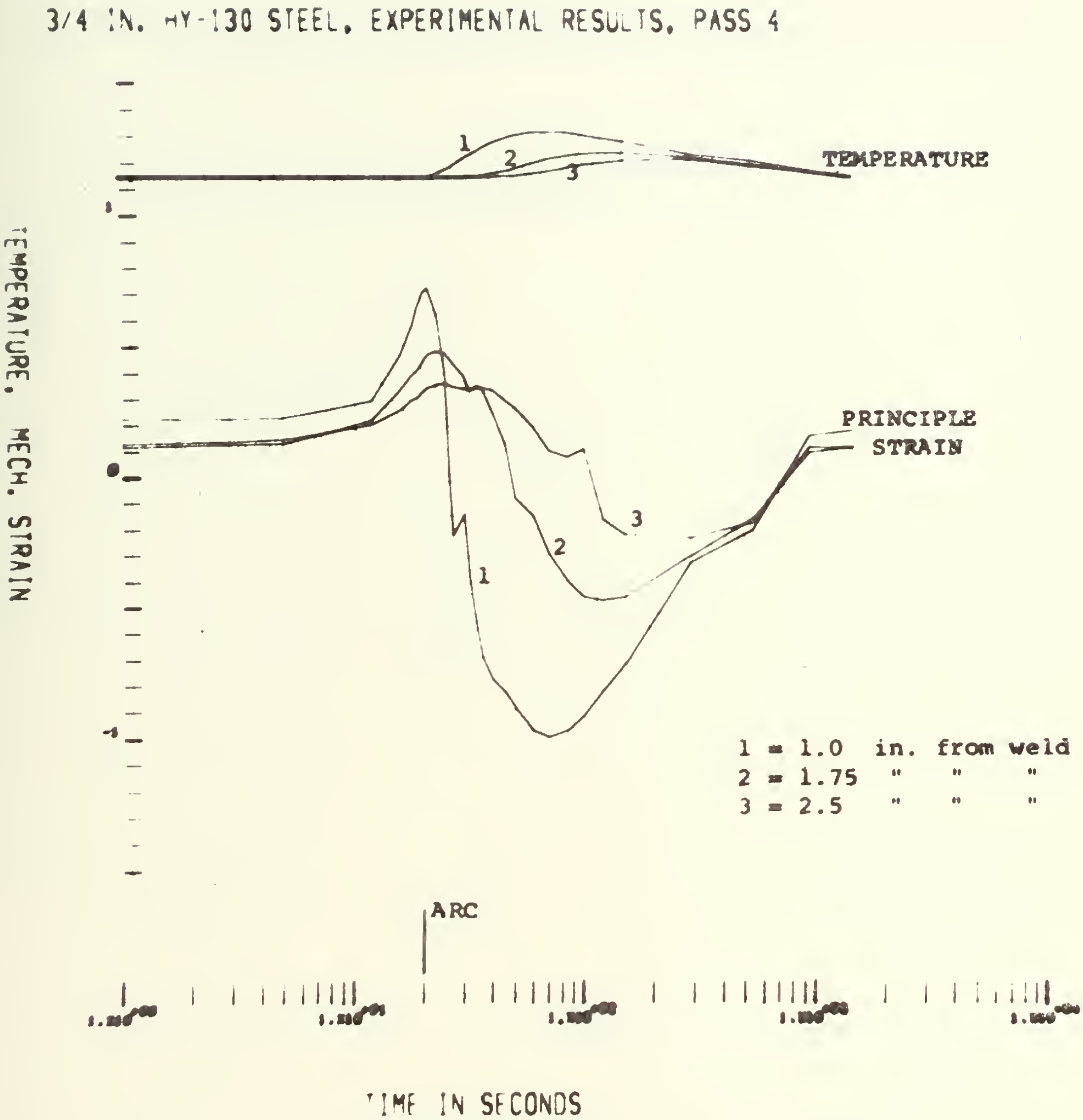

3/4 IN. HY-130 STEEL, EXPERIMENTAL RESULTS, PASS 4
TEMPERATURE
PRINCIPLE STRAIN
TEMPERATURE, MECH. STRAIN
1 = 1.0 in. from weld
2 = 1.75 " " "
3 = 2.5 " " "
ARC
TIME IN SECONDS

FIGURE 29.

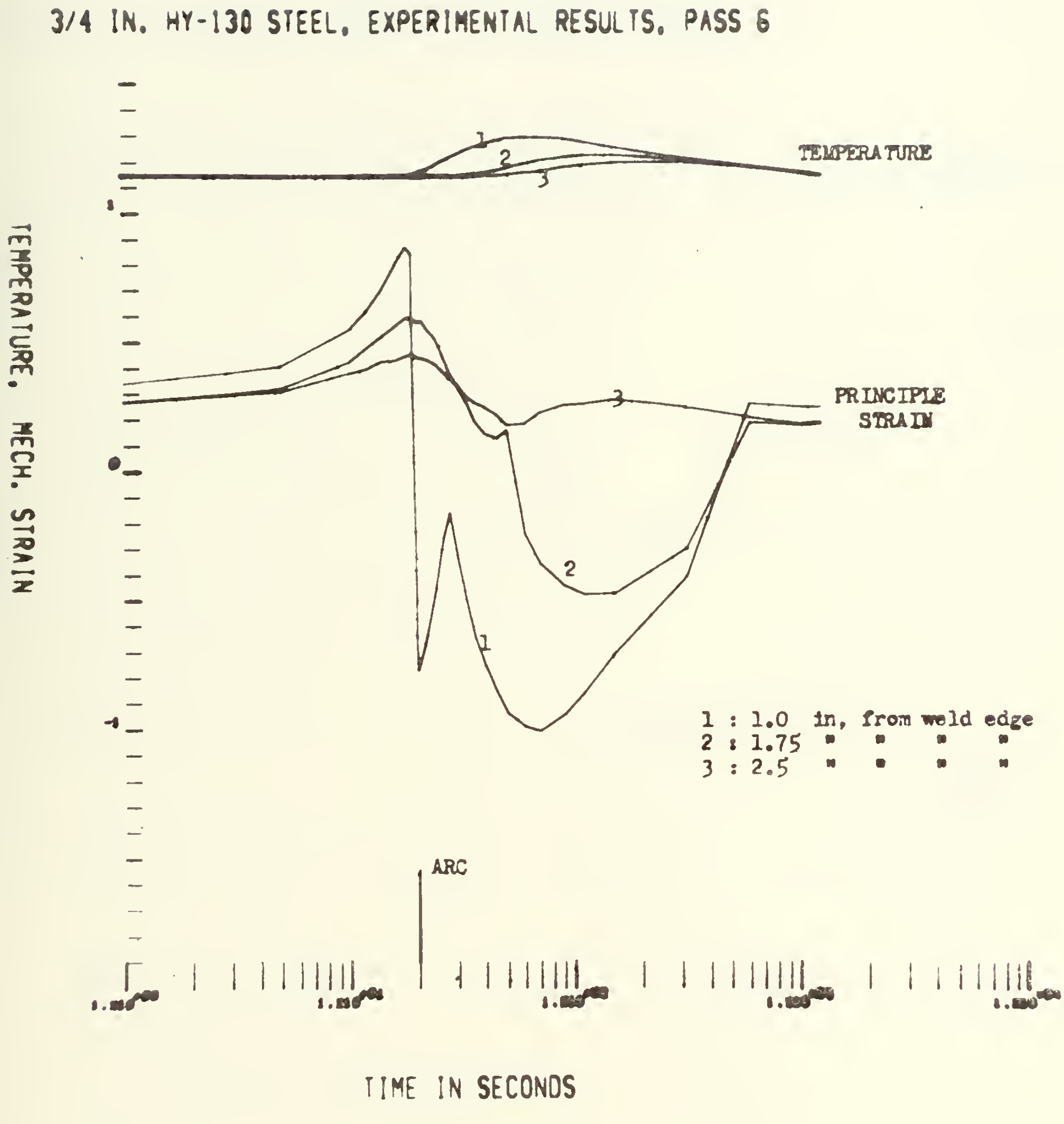

3/4 IN. HY-130 STEEL, EXPERIMENTAL RESULTS, PASS 6
TEMPERATURE, MECH. STRAIN
TEMPERATURE
PRINCIPLE STRAIN
1 : 1.0 in, from weld edge
2 : 1.75 " " " "
3 : 2.5 " " " "
ARC
TIME IN SECONDS

FIGURE 30.

3/4 IN. HY-130 STEEL, EXPERIMENTAL RESULTS, PASS 8

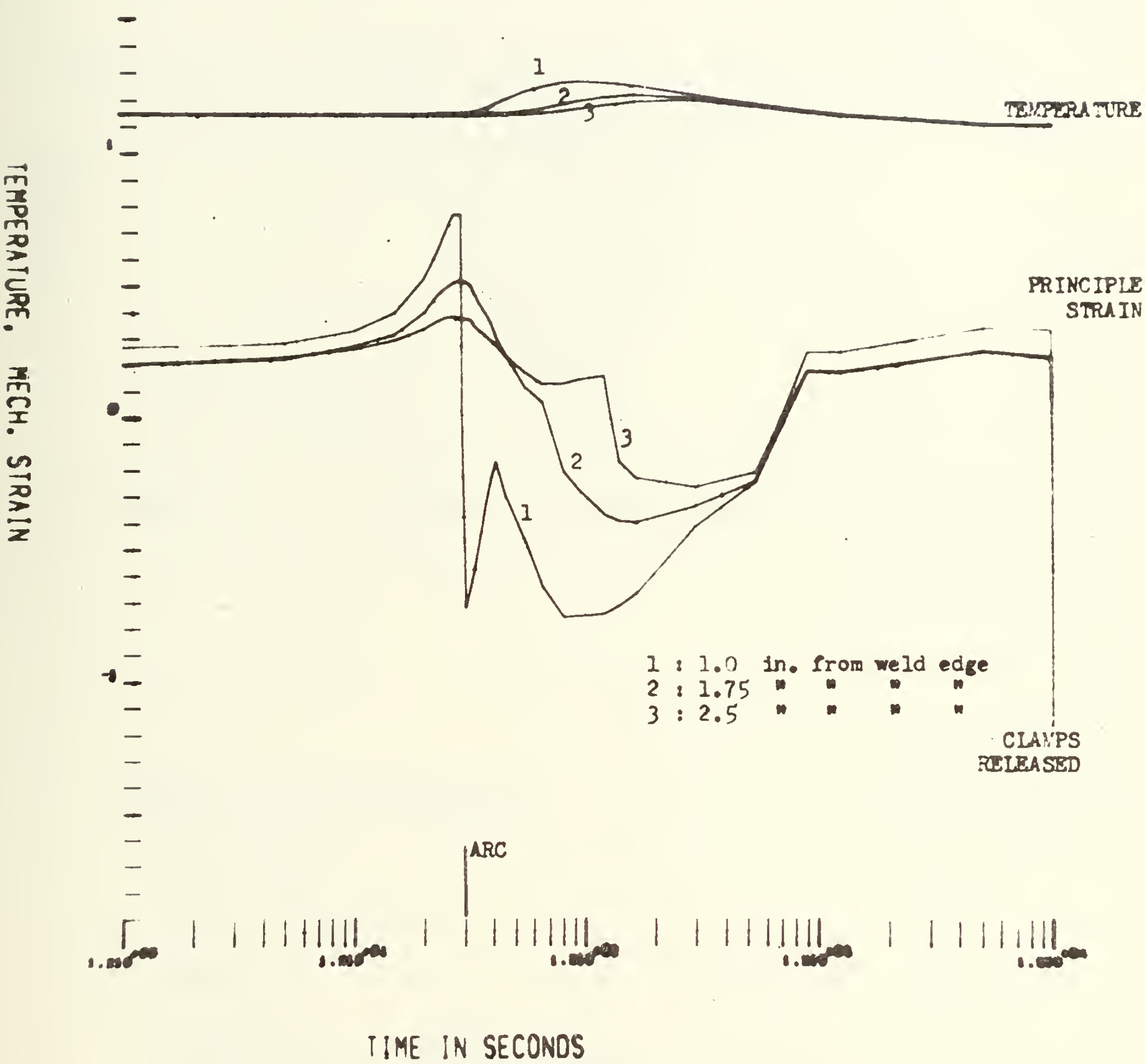


FIGURE 31.

TEST 5: 180-ksi STEEL

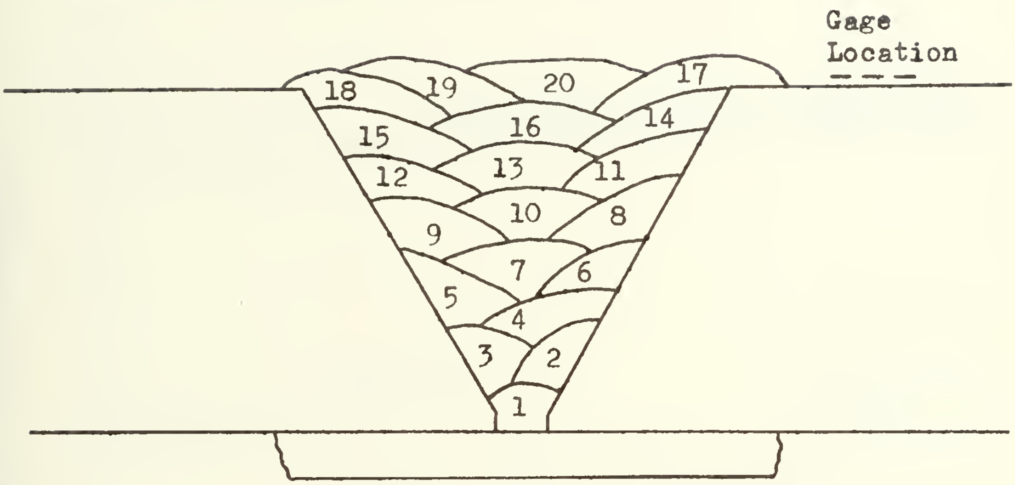


FIGURE 32. SEQUENCE OF WELD PASSES

SCALES UTILIZED IN PLOTS:

1. Horizontal.

   Time = Seconds

2. Vertical.

   $$\text{Temperature} = \frac{{}^{o}F}{1{,}000} + 1.0$$

   $$\text{Mech. Strain} = \frac{\text{in/in} \times 10^{-6}}{1{,}000} = \frac{\text{microstrain}}{1{,}000}$$

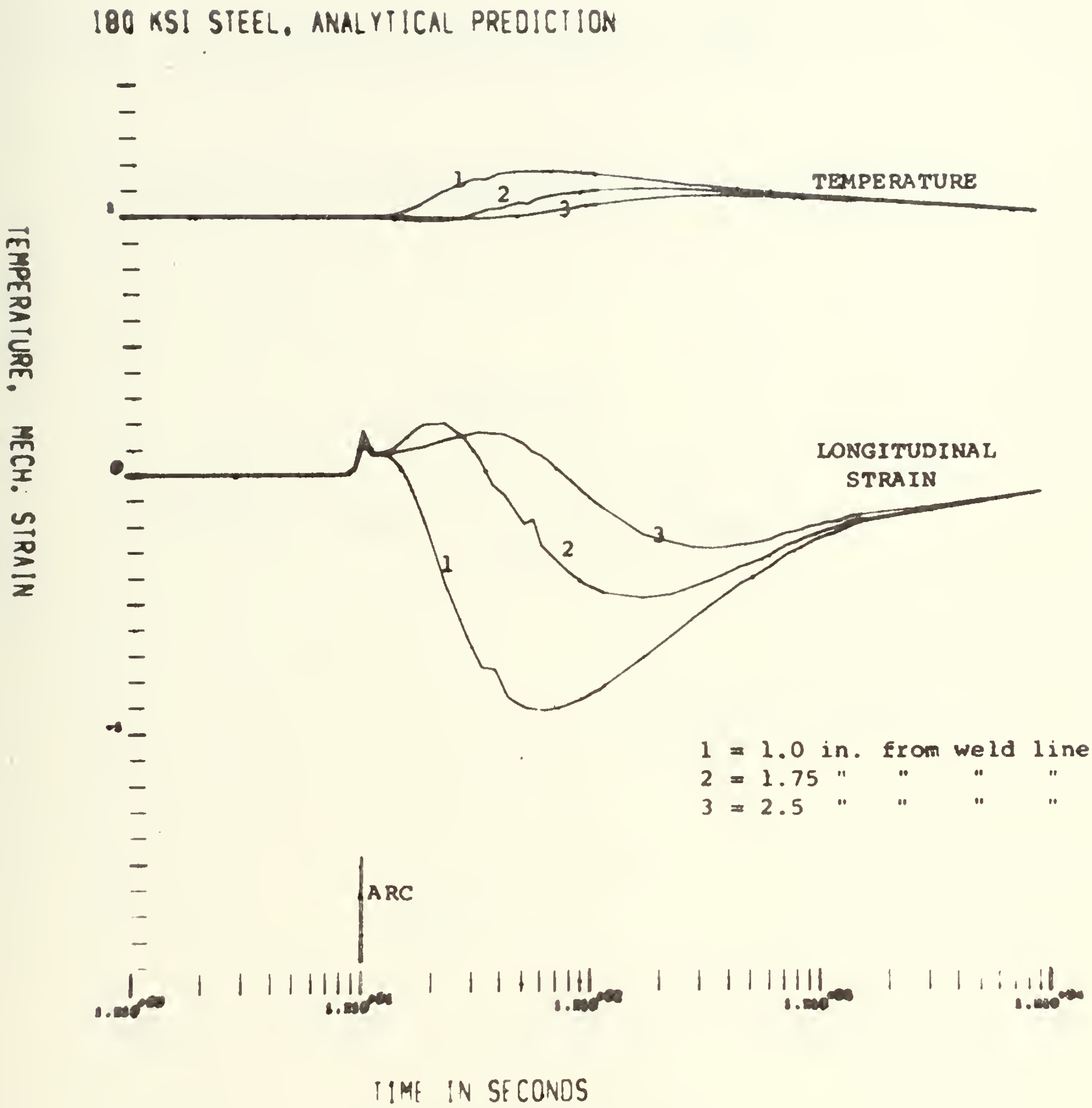

180 KSI STEEL, ANALYTICAL PREDICTION
TEMPERATURE, MECH. STRAIN
TEMPERATURE
LONGITUDINAL
STRAIN
1 = 1.0 in. from weld line
2 = 1.75 " " " "
3 = 2.5 " " " "
ARC
TIME IN SECONDS

FIGURE 33.

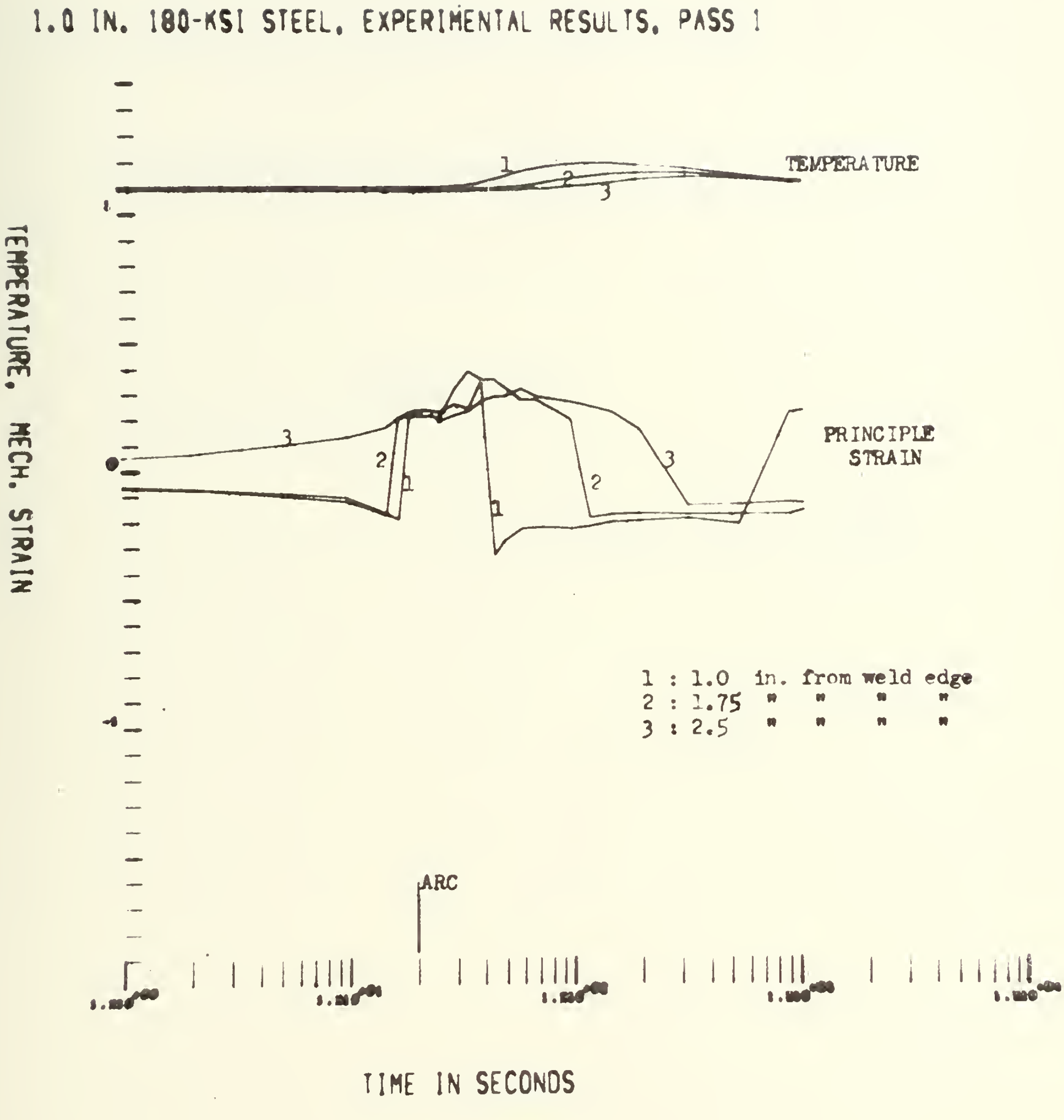

1.0 IN. 180-KSI STEEL, EXPERIMENTAL RESULTS, PASS 1
TEMPERATURE, MECH. STRAIN
TEMPERATURE
PRINCIPLE STRAIN
1 : 1.0 in. from weld edge
2 : 1.75 " " " "
3 : 2.5 " " " "
ARC
TIME IN SECONDS

FIGURE 34.

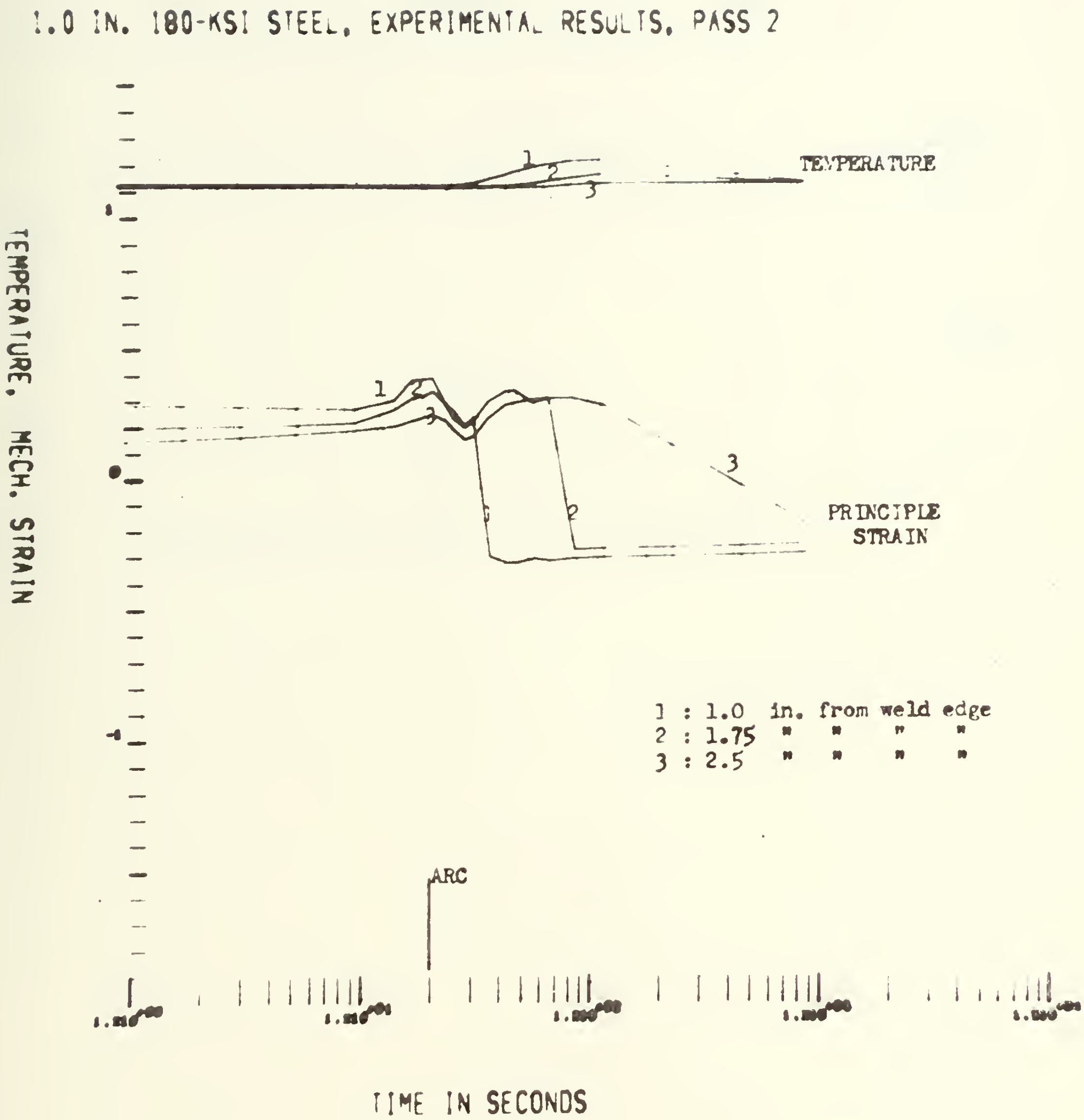

1.0 IN. 180-KSI STEEL, EXPERIMENTAL RESULTS, PASS 2
TEMPERATURE
PRINCIPLE
STRAIN
1 : 1.0 in. from weld edge
2 : 1.75 " " " "
3 : 2.5 " " " "
ARC
TEMPERATURE, MECH. STRAIN
TIME IN SECONDS

FIGURE 35.

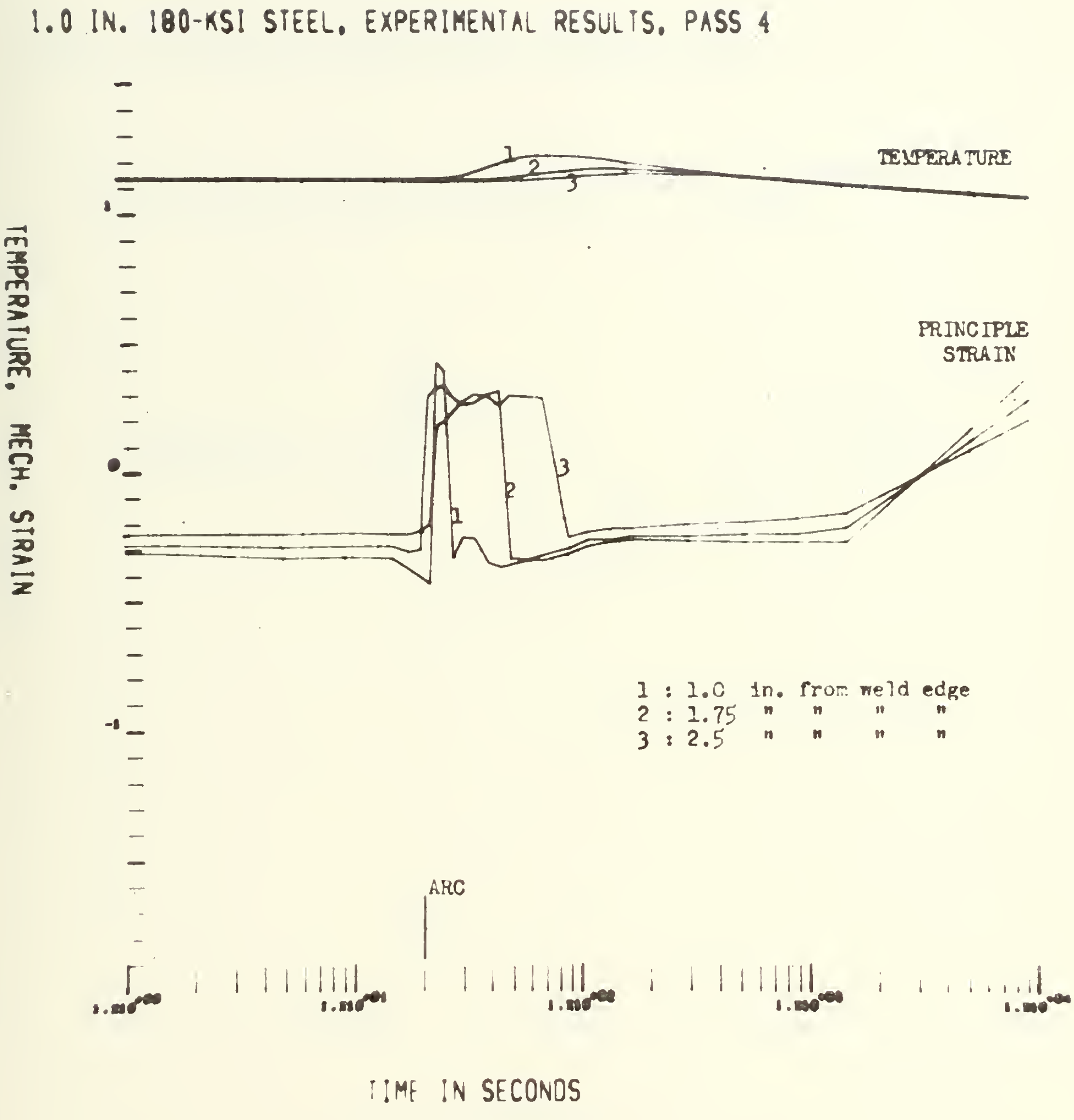
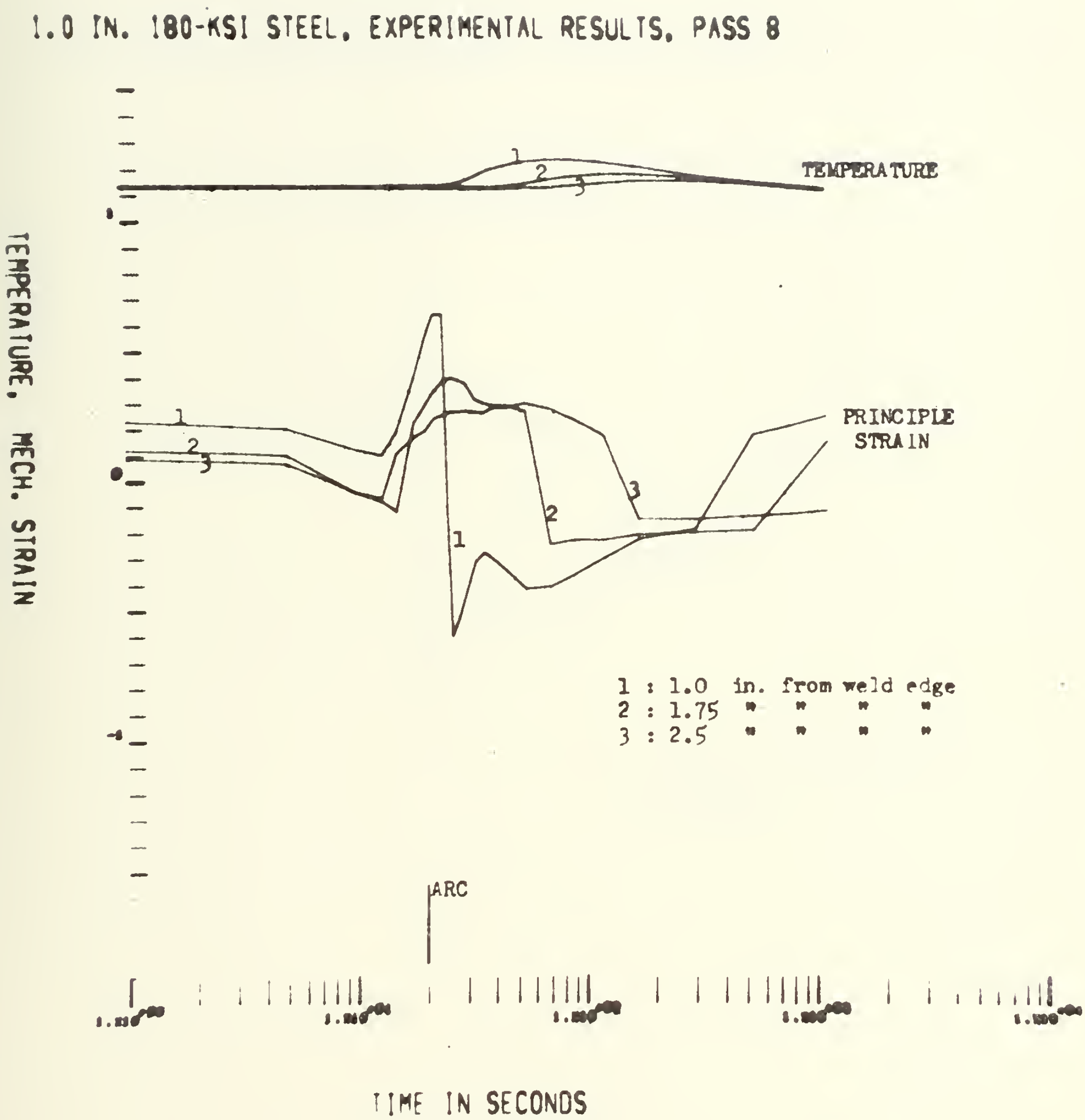

1.0 IN. 180-KSI STEEL, EXPERIMENTAL RESULTS, PASS 4
TEMPERATURE
PRINCIPLE STRAIN
TEMPERATURE, MECH. STRAIN
1 : 1.0 in. from weld edge
2 : 1.75 " " " "
3 : 2.5 " " " "
ARC
TIME IN SECONDS

FIGURE 36.



1.0 IN. 180-KSI STEEL, EXPERIMENTAL RESULTS, PASS 8
TEMPERATURE
PRINCIPLE STRAIN
1
2
3
1 : 1.0 in. from weld edge
2 : 1.75 " " " "
3 : 2.5 " " " "
ARC
TEMPERATURE, MECH. STRAIN
TIME IN SECONDS

FIGURE 37.

1.0 IN. 180-KSI STEEL, EXPERIMENTAL RESULTS, PASS 14

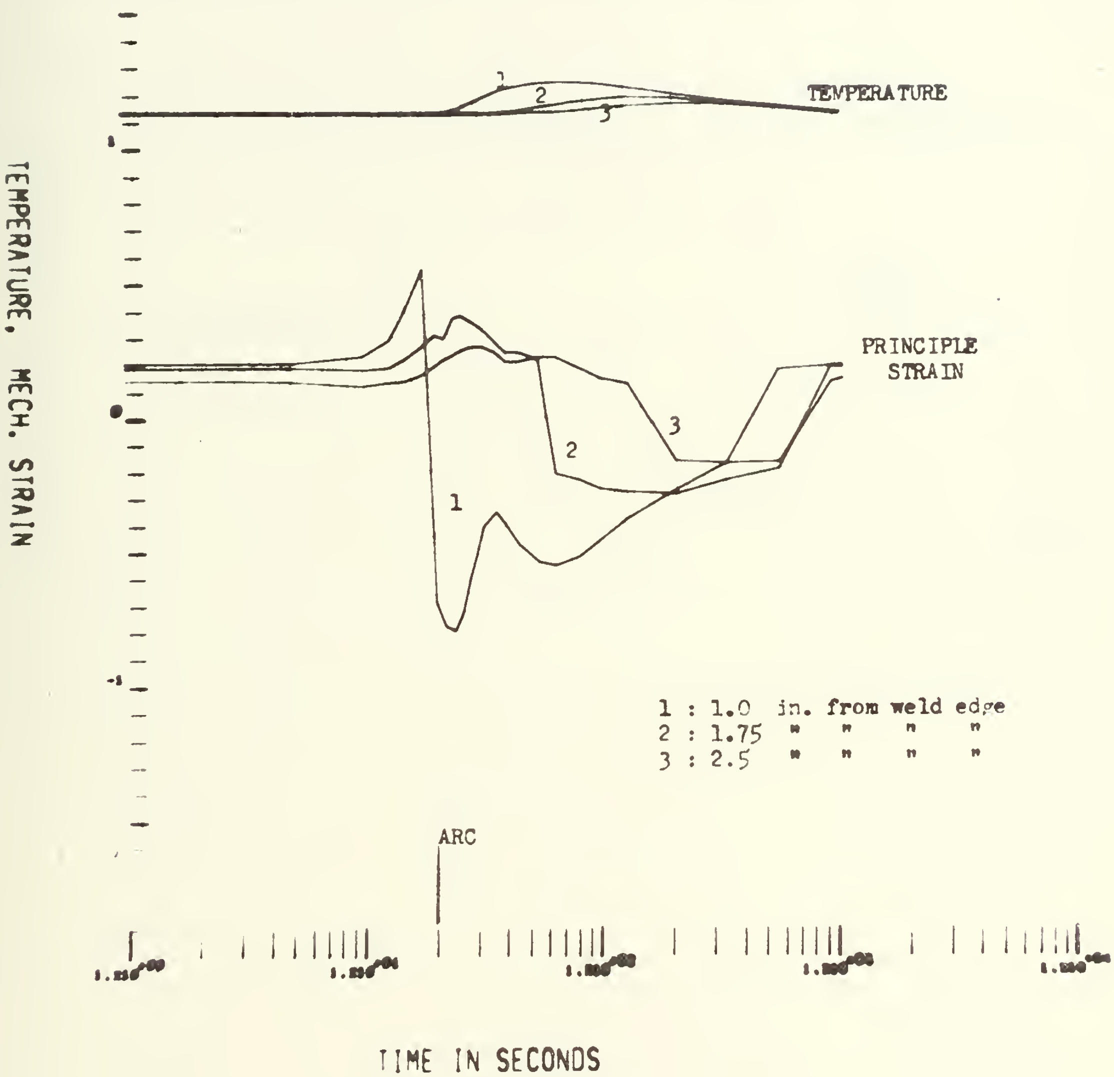


FIGURE 38.

1.0 IN. 180-KSI STEEL, EXPERIMENTAL RESULTS, PASS 17

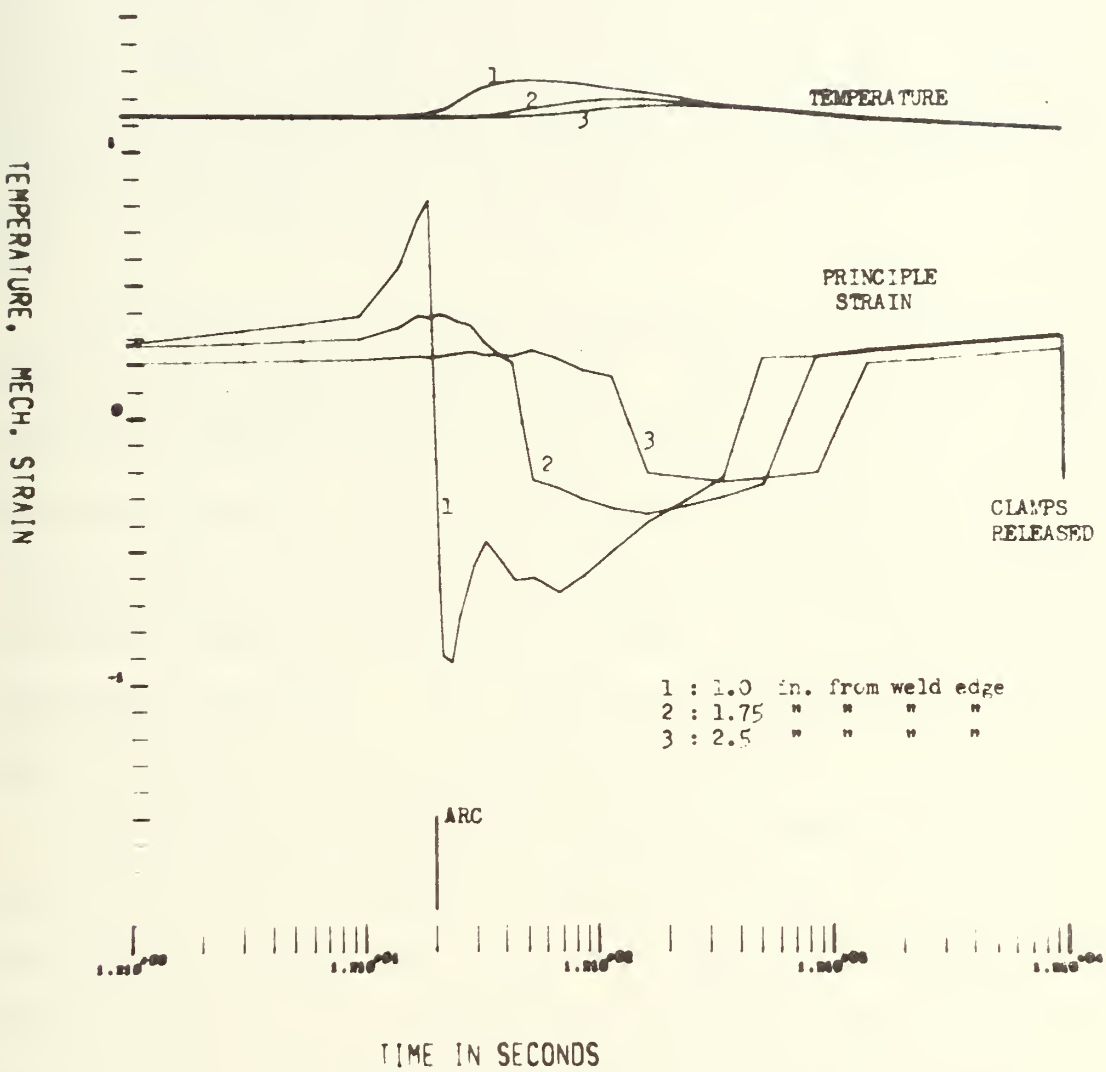


FIGURE 39.

B. Observations

The first two groups of plots show the results of the bead-on-plate welds performed at Portsmouth on 1/4-inch low carbon (mild) steel and HY-80. Figures 12 and 13 refer to the mild steel; Figures 14 and 15 refer to HY-80. On the HY-80 plate, a gage failure (shorted lead wire) occurred at the one-inch-from-weld-line location, 90.6 seconds into the run.

The third group of plots (beginning with Figure 18) refers to the 3/4-inch HY-80 plate. Weld quality for this particular specimen was impaired somewhat by a slightly excessive arc length. The arc wavered from side to side, shedding small vortices in the puddle in its wake. Although subsequent passes filled most of these voids, some porosity undoubtedly remained. The effect of these defects on the strain history is not considered significant.

The fourth set of results (beginning with Figure 27) refers to the HY-130 plate. On the first pass, several longitudinal cracks (1/4 ~ 1/2 inch long) were observed. The probable cause of the cracking was excessive constraint imposed by the 45° bevel angle. Cracking was not observed on subsequent passes and the effects of first-pass defects diminish rapidly with increasing weld metal deposition. Some porosity also occurred near the gage location in the sixth and eighth passes. Probable cause: contamination of the weld puddle by the gage protective coating. After final

cool-down on the last pass, the constraining clamps were released and another set of readings were taken (Figure 31).

The fifth set of plots refers to the 180-ksi plate. While this specimen was only 15 inches long, the weld appearance was excellent through all passes. On the last pass (Pass 20), a particle of hot spatter fell on the thermocouple leads and burned through them. Data was thus unusable for the run itself, but the leads were repaired in time to take cool-down readings. The readings were found to be identical to the Pass 17 values at time 1500 seconds, so the residual and "clamps-released" conditions were plotted at the end of Pass 17.

IV DISCUSSION OF RESULTS

A. General Trends

The variation of experimental parameters discussed earlier produced several discernable effects:

1. Effect of Preheat. Localized preheating of constrained plates imposed generally minor mechanical strain changes in areas an inch or more from the joint. These changes are reflected in the time-one-second values of strain plotted in Figures 19, 27, and 34. Magnitudes are too small in relation to experimental accuracy to indicate any clear trend. In the case of the .55-inch location on the 3/4-inch HY-80 plate, preheat imposed a highly compressive strain indication (Figure 19). This indication is viewed with some suspicion, however, since it was registered on HT gages. More will be said about this later.

2. Section Thickness and Multipass Effects. Comparison of thin-section, bead-on-plate welds with thick-section, multipass welds reveals a definite trend. The strain response of thicker plates does not develop into the clearly discernable pattern observed on thin sections until several passes have been deposited. For the HY-130 plate, the pattern begins to take shape in the fourth pass (Figure 29); for 180-ksi, it is the eighth pass (Figure 37). The slow development of this pattern is undoubtedly caused by the relatively long distance between the early passes and the gage locations.

As shown in Figure 17, the gages were placed on the top surface of the thick plates near the edge of the bevelled joint. As weld metal fills the joint openning, successive passes are deposited closer to the gages and thus produce greater effects by reason of their proximity. Looking beyond proximity variations, section thickness effect can be assessed by comparing the strain response of the 1/4-inch HY-80 plate tested in Portsmouth with that of the 3/4-inch HY-80 plate welded at M.I.T. Passes 11 and 18 on the 3/4-inch plate (Figures 22 and 24) were deposited at the same distance from their respective 2.5-inch gage locations as the single pass on the 1/4-inch plate (Figure 16). Both passes on the 3/4-inch plate produced smaller responses at the gage than was measured on the 1/4-inch plate. These results are consistant with the theoretical predictions plotted in Figures 14 and 18. The larger mass of metal in the thick section distributes and dissipates arc heat more readily and also provides greater constraint, both of which limit metal movement.

The effect of multiple passes recorded in this investigation is obscured by the proximity variations. Residual strains do appear to accumulate in the early passes (that is, the strain state reached by the last pass becomes the starting point for the next pass which then reaches a still higher residual strain state). The last few passes on each plate, however, show little or no cummulative trend.

Figure 40, for example, shows passes 4, 6, and 8 on the HY-130 plate (all deposited approximately the same distance from the gage locations). There is essentially no difference in the response of the plate to these passes. This is not inconsistant with the findings of previous investigators. Kasatkin found that on small specimens, permanent strains immediately under the weld line increased markedly during *four* passes of a tungsten arc.[18] As indicated in Figure 41, he also found that the direction of arc travel had a significant effect on the residual strain state. Kihara and Masubuchi measured transverse shrinkage on welds of *more* than four passes and found that the response levels off logarithmically during later passes (Figure 42).[24] It appears reasonable to infer, therefore, that the principle strains accumulating during multi-pass welding also build up logarithmically, with the greatest increase in residual strain occurring in the early passes.

3. Effect of Plate Strength. As the strength level of the test plates increased from 30 to 180 ksi, the magnitude of both transient and residual welding strains decreased. At the one-inch-from-weld location, the transient response of the higher strength steels is noticeably less than that of the low carbon (mild) steel or even HY-80. To obtain a quantitative measure of this trend, the maximum transient strain change recorded during any pass on a plate was plotted vs base plate yield strength (Figure 43). The results indicate

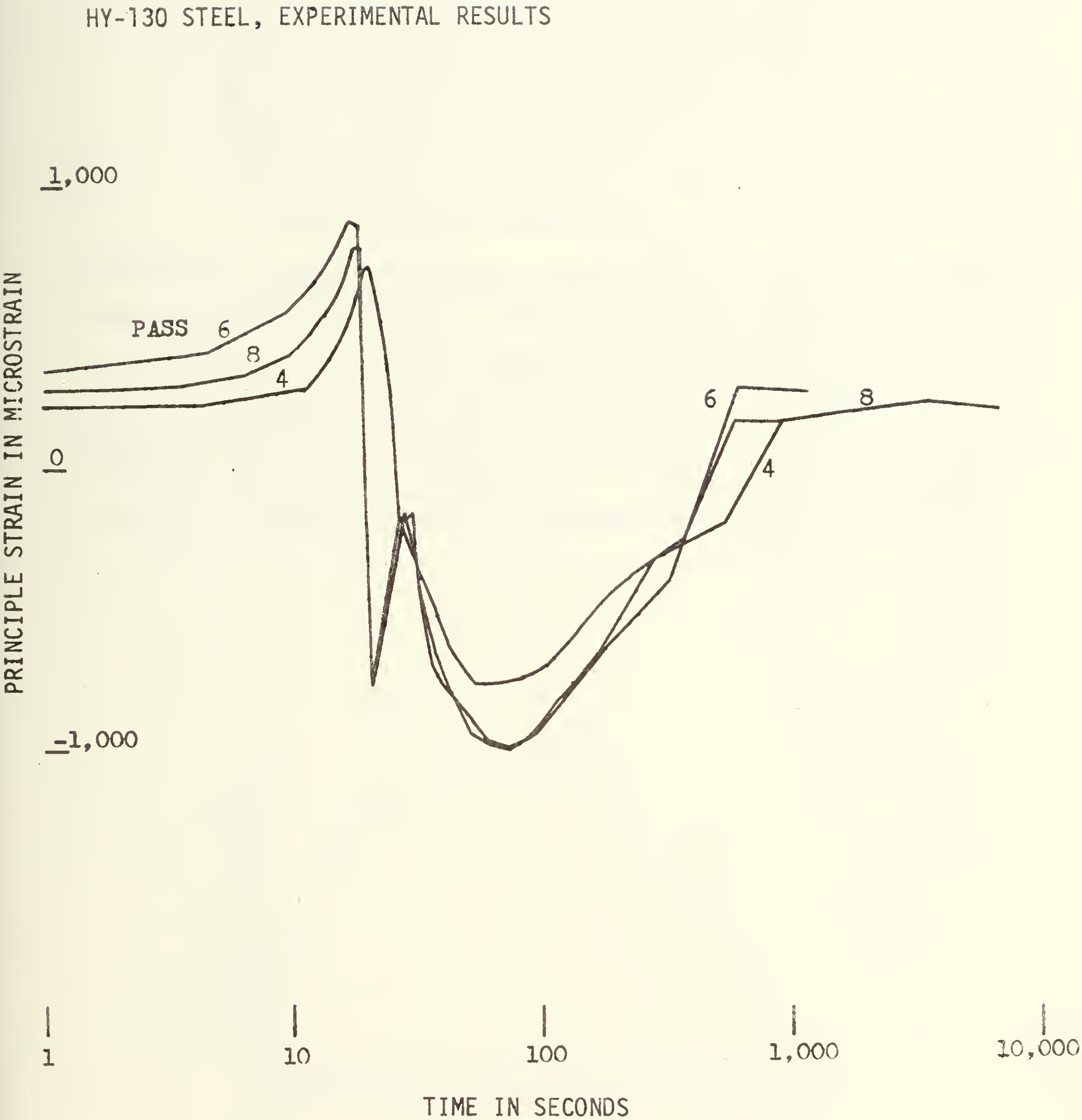


FIGURE 40. MULTI-PASS EFFECT. COMPARISON OF PRINCIPLE STRAIN RESPONSE DURING PASSES 4, 6, AND 8. (STRAINS MEASURED ONE INCH FROM THE WELD LINE.)

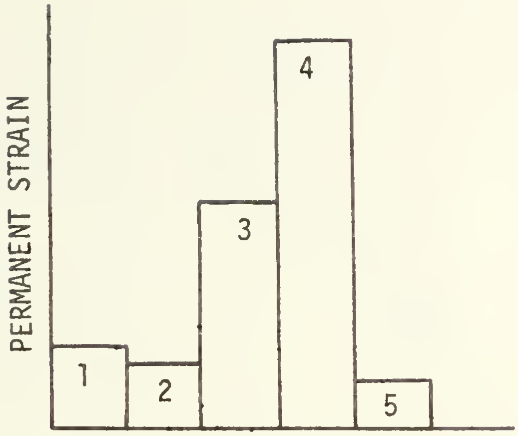


FIGURE 41. DIAGRAM OF PERMANENT MOVEMENTS OF A POINT WHEN SILICON IRON IS WELDED BY DIFFERENT VARIATIONS OF MULTI-PASS WELDING: 1. SINGLE-PASS; 2. TWO-PASS WELDING IN DIFFERENT DIRECTIONS; THE FIRST BEAD COOLED BEFORE DEPOSITING THE SECOND; 3. THREE-PASS WELDING IN ONE DIRECTION, WITH EACH BEAD COOLED BEFORE DEPOSITING THE NEXT; 4. THE SAME, NO COOLING; 5. FOUR-PASS CONTINUOUS WELDING WITH THE BEADS DEPOSITED IN ALTERNATE DIRECTIONS. (KASATKIN)

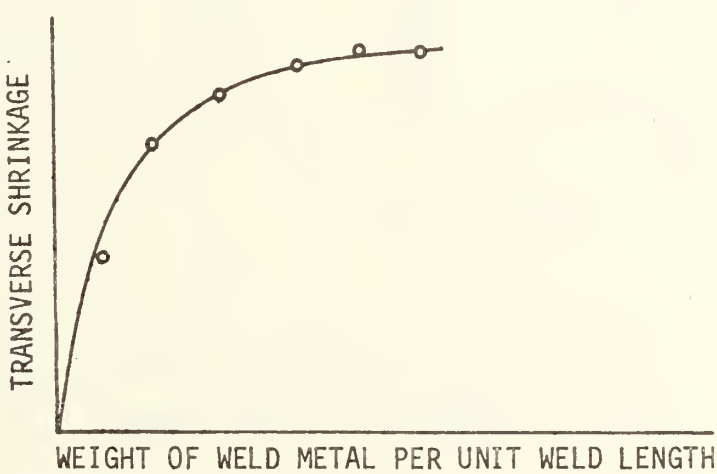


FIGURE 42. INCREASE IN TRANSVERSE SHRINKAGE DURING MULTI-PASS WELDING OF A BUTT JOINT. (KIHARA AND MASUBUCHI)

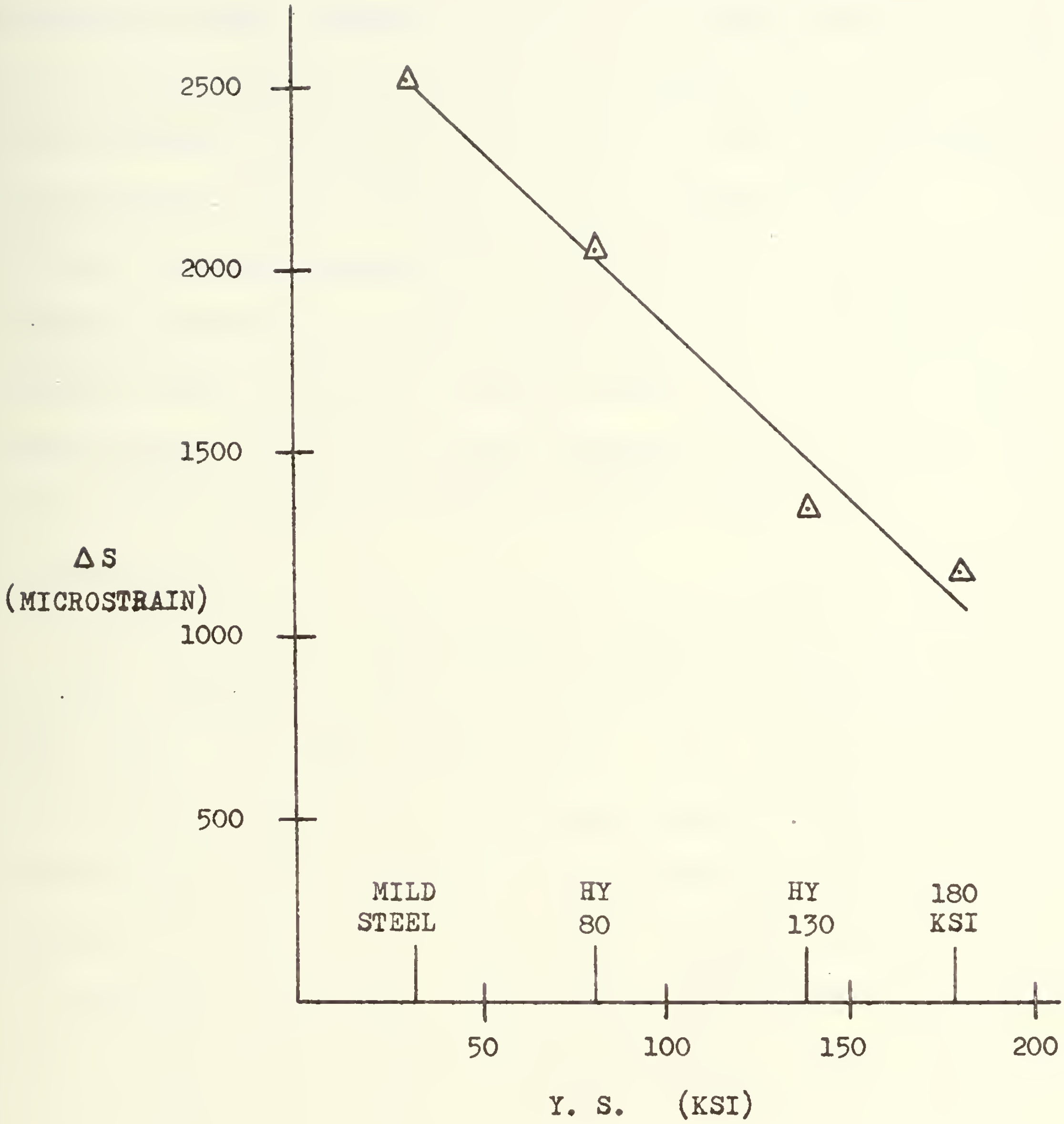


FIGURE 43. CHANGE IN WELDING MECHANICAL STRAIN (ΔS) vs. BASE PLATE YIELD STRENGTH (Y. S.)

that the strain response is roughly proportional to the inverse of plate strength. This can be explained by noting that of the parameters directly affecting weld strain, only yield strength changed significantly in these experiments. (The same can also be said of most production welds.) Young's modulus, thermal expansion and conductivity coefficients, density, and heat-input-per-square-inch all varied only slightly while strength increased 600%. As a result, only a very narrow zone on the high strength steels yields plastically and the strains observed outside that zone are proportionately small.

Because of the lower strain response, the data describing the early passes on the 180-ksi plate are misleading. In these first few passes (Figures 34 - 37), the strain level was too low to show any predominance among longitudinal, transverse and shear strains. Consequently, the two principle strains, oriented 90° to each other and opposite in sign, were of comparable magnitude. Since only the largest of these two strains is plotted, abrupt changes show up in the curves when one principle strain edges the other. The strain state itself changes much more gradually.

Both of the two highest strength steels (HY-130 and 180-ksi) displayed an unusual phenomenon in the later passes. In Figures 29 - 31 and 37 - 39, a secondary tensile peak was observed in the strain response a few seconds after the arc had passed. Since there is no evidence of this response in

any of the lower strength steels or in the aluminum plates tested by Masubuchi and Arita,[14] the phenomenon is probably a material characteristic. The time-temperature history of the arc passage points to a possible phase transformation or precipitation reaction in the immediate area of the weld as the probable cause of the second peak. The transformation from Austenite to Bainite or Martensite, as discussed in a previous section, might cause a sudden compressive strain in the weld area itself and a corresponding tensile strain in surrounding areas.

4. Correlation between Principle and Longitudinal Strains. Figures 44 - 46 indicate the correlation between principle and longitudinal strains. As mentioned previously, relatively low strain levels at the beginning and end of each pass produced less predominance on the part of the longitudinal strains and thus less correlation with the principle strains during these periods. Correlation was also diminished at the point in time when the arc passed the gage location--due to presence of high transverse and shear strains. All other observations showed principle and longitudinal strains to be quite close.

B. Comparison of Experimental Results with Theoretical Predictions

The NASA computer programs used in this investigation provide a one-dimensional solution to a simple, single-pass,

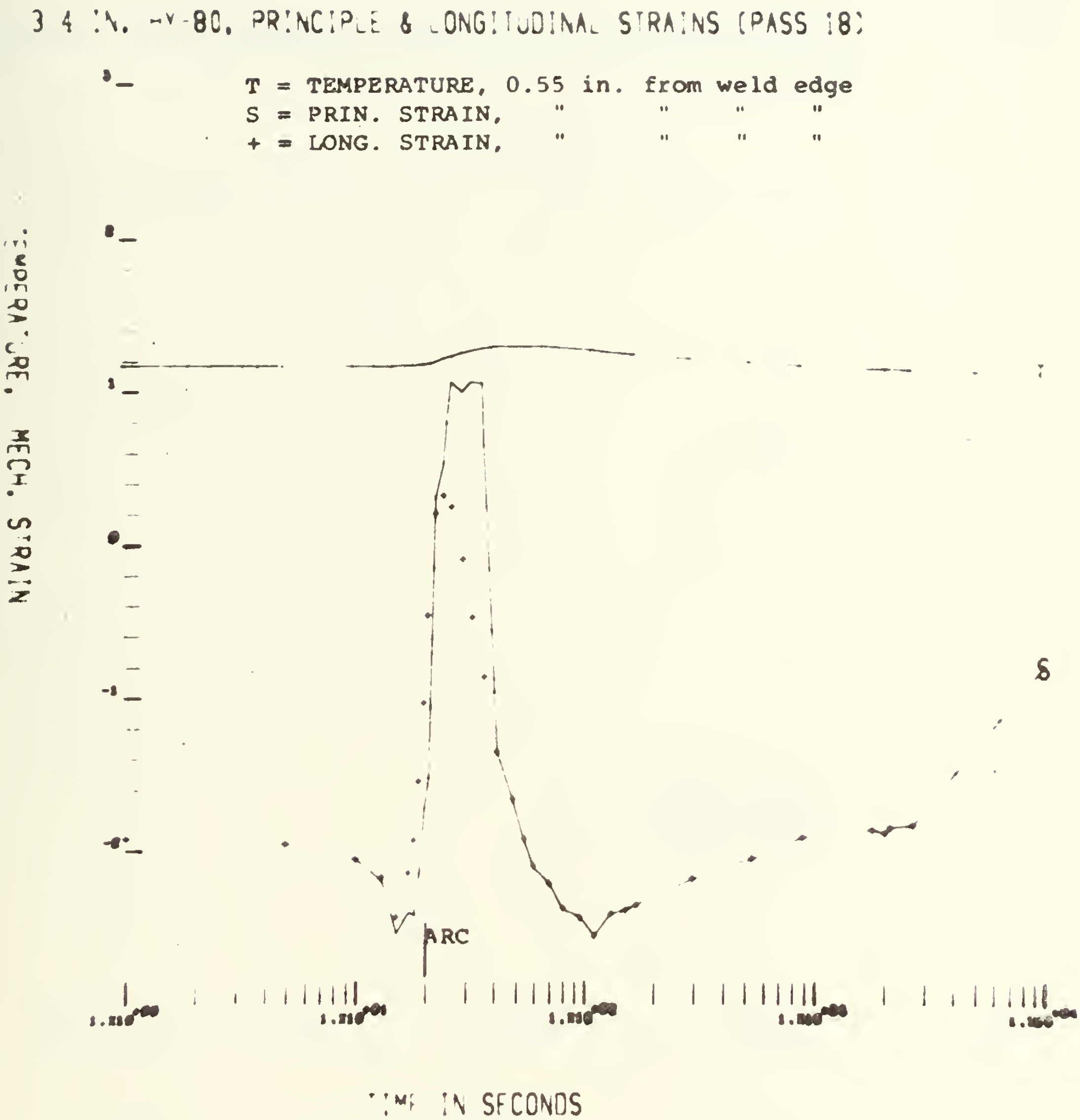

PRINCIPLE & LONGITUDINAL STRAINS (PASS 18)
T = TEMPERATURE, 0.55 in. from weld edge
S = PRIN. STRAIN, " " " "
+ = LONG. STRAIN, " " " "
MECH. STRAIN
ARC
S
IN SECONDS

FIGURE 44.

3/4 IN. HY-130, PRINCIPLE & LONGITUDINAL STRAINS (PASS 6)

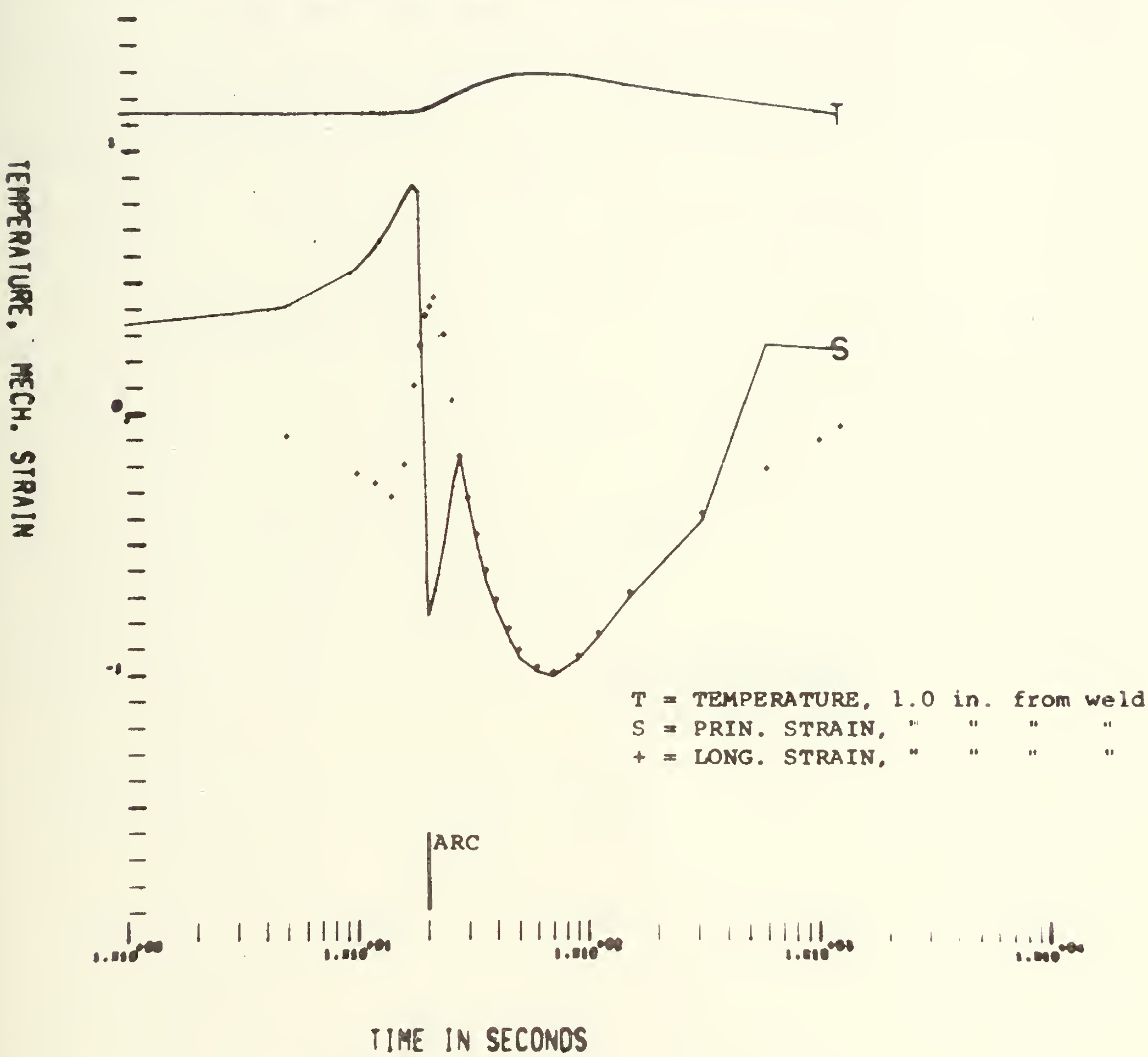


FIGURE 45.

1.0 IN. 180-KSI, PRINCIPLE & LONGITUDINAL STRAINS (PASS 17/20)

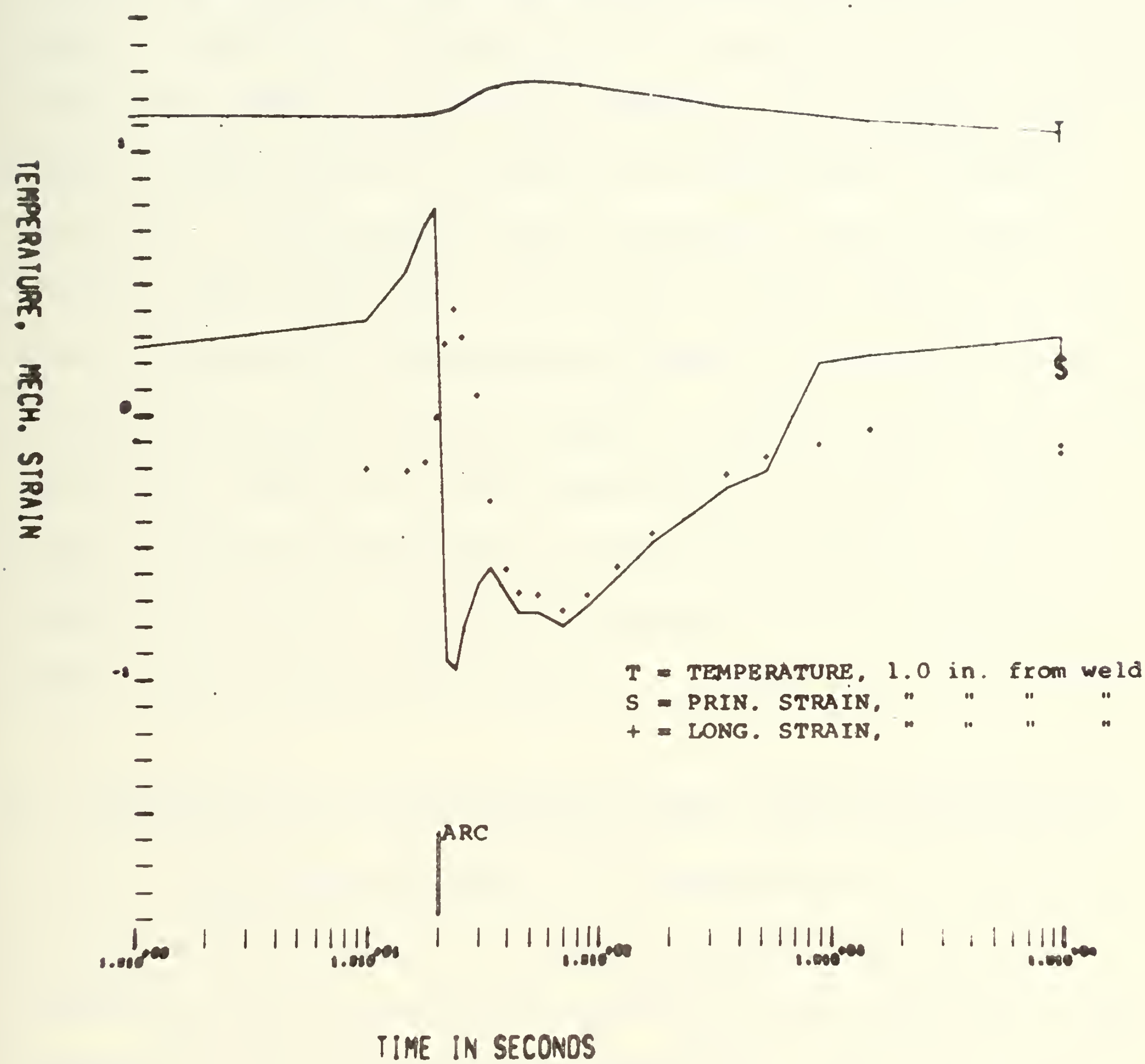


FIGURE 46.

thin-section weld model. The correlation between principle and longitudinal strains just discussed and the relatively small deviation between thin and thick section effects provide a key to the applicability of the programs to more complex weldments. In general, the predictions were accurate as to the trend of the strain response, the maximum value of strain imposed, and the effects of significant parameter variations. The programs did not predict the secondary tensile peaks observed in the high strength steels nor did they anticipate the cummulative effects of multipass welding. (Correlation with the later passes would be excellent if the analytical prediction were displaced so that its initial strain reading matched that of the experimental curve.) Computer solutions were also inaccurate in the immediate area of the welding arc itself.

C. Accuracy of the Experimental Model and Instrumentation

1. The Physical Model. As mentioned in the discussion of parameter selection, the plate geometry, the level of constraint, and the welding procedures are considered representative of ship fabrication processes. The small size of the 180-ksi specimen did not appear detrimental when its response was compared to that of the larger plates of other strength levels.

2. Data Reduction Calculations. The accuracy of the data reduction technique discussed in Section II-C and

programed in Appendix A rests primarily on one crucial assumption: that of "Linear Superposition." It is assumed that the effects of mechanical strains, temperature induced thermal strains and gage thermo-electric effects do not interact with each other and can be added or subtracted linearly. This approximation is valid only when the mechanical strains are large in relation to the thermal effects.

3. Instrumentation. Two key factors affect the accuracy of the instrumentation: the size of the sensing elements and their thermal response characteristics. The largest dimension of any single sensor element is 0.25 inches. This is small compared to the other length dimensions involved in the geometry. The area covered by the entire gage rosette is large, but this has been corrected by time delays mentioned in the description of procedures.

The thermal response characteristics of the SR-4 strain gages are ideal for this investigation. They are relatively insensitive to temperature changes when mounted on steel plates. As indicated in Figure 47, the maximum amount of apparent strain correction required is 130 microstrain. The HT gages are another matter, however. Figure 48 indicates a constant Apparent Strain-Temperature slope of 38.6 microstrain per °F. Thus, as temperature increases from 70° F ambient to a peak of only 360° F, the apparent strain correction becomes more than 11,000 microstrain. When compared to a calculated mechanical strain maximum of less than 2,700

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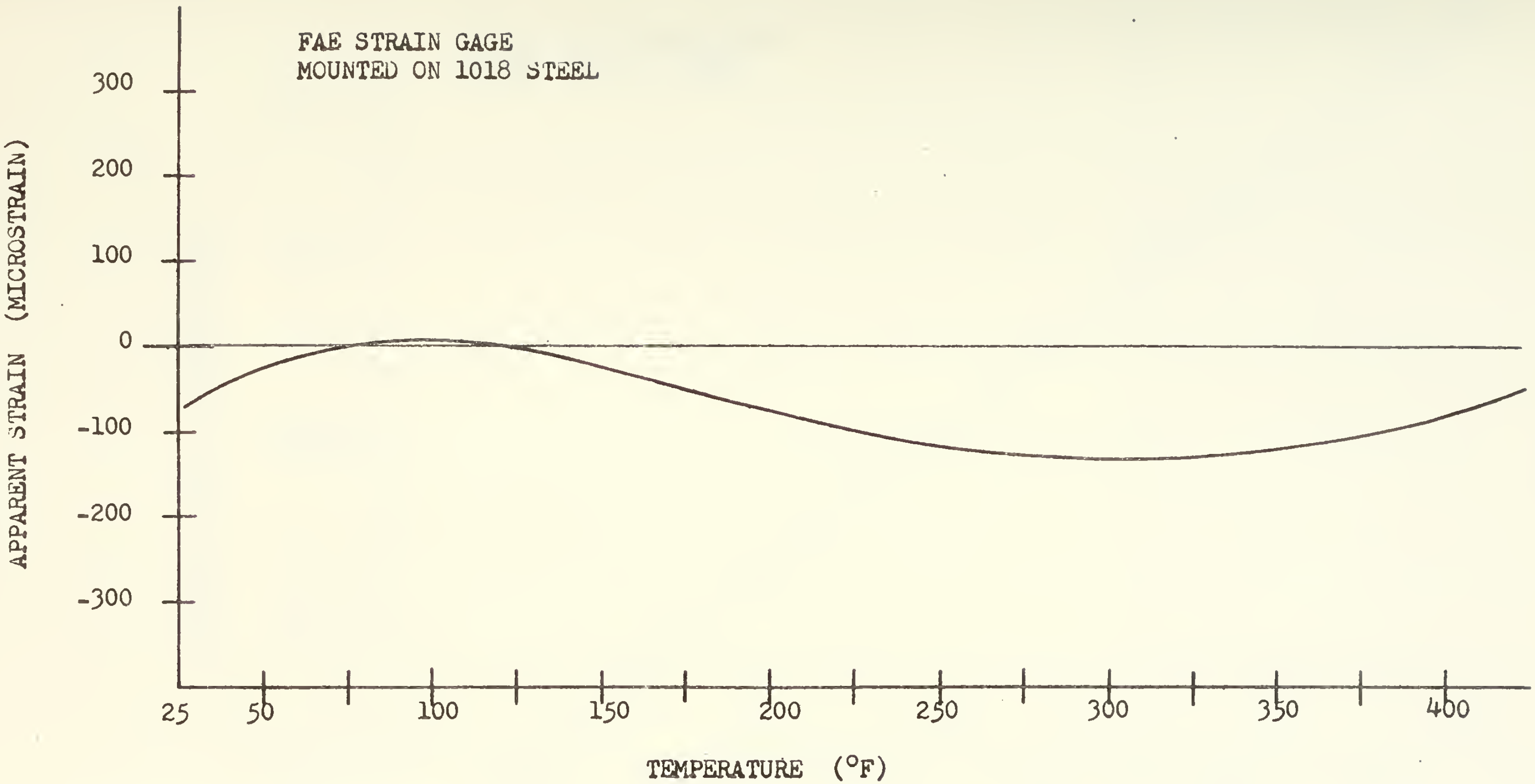

FIGURE 47. APPARENT STRAIN - TEMPERATURE CURVE, SR-4 STRAIN GAGES.

BLH DWG.NO. 217119-1

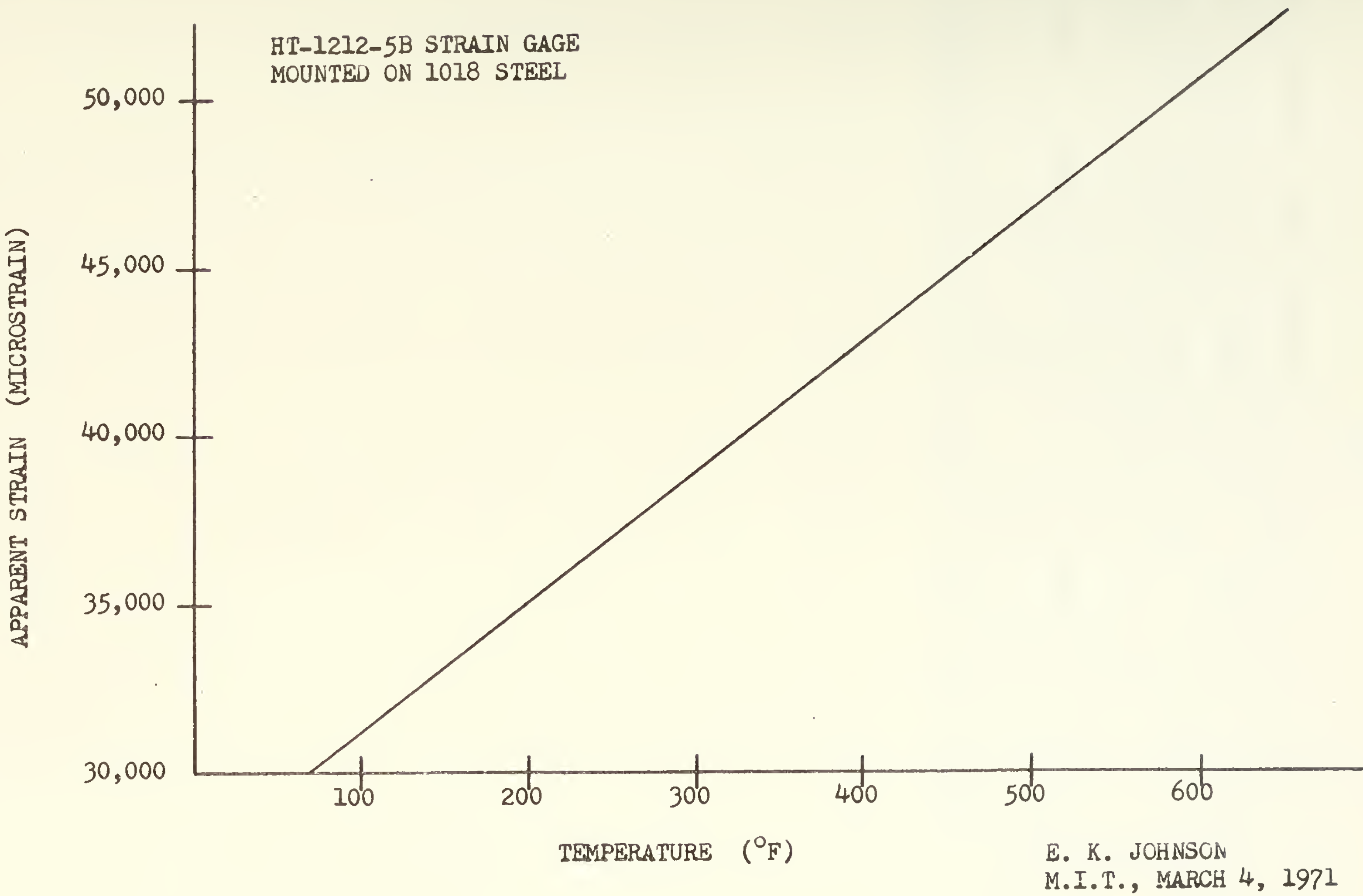

FIGURE 48. APPARENT STRAIN - TEMPERATURE CURVE, HT-1212 STRAIN GAGES.

microstrain, the assumption mentioned in Paragraph C-2 of this Section is no longer valid. Even if the Linear Superposition assumption were still valid, a 5% error in temperature or measured gage resistance would result in a 20% error in mechanical strain. As a result, the data recorded at the 0.55 inch location on the 3/4-inch HY-80 plate is considered unreliable and must be used with caution.

V CONCLUSIONS

Based on the preceding discussion, the conclusions reached in this investigation are:

1. The NASA weld analysis computer programs developed by Masubuchi and his coworkers *are* applicable to steel butt welds in marine structures. The programs can be used to compare alternative parameter variations as long as the point of interest is not located in the immediate area of the welding arc itself.
2. The thermal strain response of thick section plates to a single weld pass is slightly less than the response of thin section plates under the same conditions. Multiple passes, however, produce cummulative strain effects especially during the first few passes. Little or no accumulation is noted in later passes.
3. At a finite distance from the weld line, maximum mechanical strains caused by the welding arc are roughly proportional to the inverse of base plate yield strength.
4. In certain ultra-high strength steels, the passage of the welding arc produces an unusual strain response possibly linked to phase transformations during cooling.

5. Except in the immediate area of the welding arc itself, the longitudinal strain predominates over transverse and shear strains. Near the arc, the strain field is complex and rapidly changing.
6. The BLH HT-type high-temperature strain gages are not suitable for in-process welding experiments similar to those performed in this investigation.

VI RECOMMENDATIONS

It is recommended that research be continued with the aim of developing techniques for the production use of the NASA programs. While it would be profitable to attempt further parameter variations in laboratory experiments similar to those performed here, the next step should be to move the investigation to the Building Ways. I recommend that a ship construction project be selected and a number of production joints instrumented for in-process data collection. Parameter selection will undoubtedly be restricted by availability and minimum interference considerations, but this would not degrade the value of the results. Computer predictions run on the welds can be compared to the experimental results and a set of procedures can be worked out to use the programs as design and production tools.

The NASA computer programs should be expanded to include procedures for calculating the effects of preheat and varying levels of joint constraint. The programs could also be adapted to utilize their own output as a new set of initial conditions for multipass welds. Also, as stated in the NASA reports, two-dimensional solutions would provide more accurate information, especially in the area of the welding arc itself.[14]

The value of the experiments performed in this investigation is directly proportional to the proximity of sensing elements to the weld bead. While HT gages were found

unsatisfactory, I recommend that other types of very high temperature gages be utilized and examined. Available models with good temperature compensation properties include: BLH Nichrome-V bonded or weldable gages (maximum temperature over 750° F), Microdot, Inc. MG-120 and 220 weldable gages (650° F) and equivalents manufactured by Micro-measurements, Inc. It is hoped that temperature compensated gages will be produced in the near future which will allow strain measurements to be taken in areas where welding temperatures peak at over 1,000° F.

More strain-temperature data is needed on the ultra-high strength steels to verify the secondary tensile peaks observed in this investigation. Specimens should be instrumented, heated to elevated temperatures and air-quenched. The results can then be compared to the welding strain response and theories postulated to explain the phenomenon.

APPENDIX

APPENDIX A

DATA REDUCTION COMPUTATIONS

The computer program appearing in this Appendix was used to convert the output of the strain gage recorder (Visicorder) into the data tabulated in Appendix B. The program was written in FORTRAN and utilizes two mathematical models. It receives strain and temperature input in the form of offsets--linear displacements of the Visicorder tracing proportional to the resistance changes in the strain gages and thermocouples. The thermocouple readings are converted to temperature directly by means of calibration curves, but the strain readings are reduced by means of the model discussed in Section II-C, "Strain Measurement by Electric Resistance Strain Gages." Strain readings, S(I, J), are read in and converted to micro-strain by calibration curves (utilizing a parabolic interpolation function, "FILLIN"). Apparent Strain corrections are made and the three readings from the strain rosette are combined into principle strains using the Mohr's Circle model.

The example listed below uses HY-130 data. Other computations require changes in calibration curves and in the call sequence for the Mohr Function. For this reason, some of the statements appearing in the program are superfluous for this particular example. Also, some manipulations of the data were performed to provide input to plotting programs.

```
      ******* DATA REDUCTION COMPUTATIONS  *******
C     EXAMPLE 1.    3/4 IN. HY-130 STEEL

C     WELDING STRAIN-TEMPERATURE VARIATION, EXPERIMENTAL RESULTS
      WRITE(6,110)
 110  FORMAT (' WELDING STRAIN-TEMPERATURE VARIATION, EXPERIMENTAL RESUL
     1TS'/'-------------------------------------------------------------'
     1///)
      INTEGER NPAS,PASS,SENS,PTS
      REAL MOHR
      DIMENSION WELD(9),PROC(9),METAL(9)
C     INPUT: METAL TYPE,THICKNESS,WELD PROCESS,WELD TYPE,
C     CURRENT,VOLTS,AMPS,TRAVEL SPEED,NO.SENSOR LOCATIONS,NO.POINTS.
      READ (5,120) (METAL(I),I=1,2),THKSS,(PROC(I),I=1,2),(WELD(I),I=1,4
     1),NPAS,CUR,VLT,AMP,V,SENS,ALPH1
 120  FORMAT(2A4,F5.3,6A4,I3,A4,F6.0,2F5.1,I5,F10.4)
      WRITE(6,130) (METAL(I),I=1,2),THKSS,(PROC(I),I=1,2),(WELD(I),I=1,4
     1),NPAS,CUR,VLT,AMP,V
 130  FORMAT(' METAL=',2A4,3X,'STEEL'/' THKSS(IN)=',F5.3/' WELD PROCESS=
     1',2A4/' WELD TYPE=',4A4/' NO.PASSES=',I3/' CURRENT=',A4/' ARC VOLT
     1AGE=',F6.0/' AMPS=',F5.0/' SPEED OF TRAVEL (IPM)=',F5.1/////28X,
     1'TRANSVERSE DISTANCE FROM WELD.'//5X,'TIME',17X,'1.00',12X,'1.75',
     112X,'2.50'///)
      J=SENS
      DIMENSION T(99),S(99,3),TZERO(99),SZERO(99,3),TEM(20),ALPHA(20)
      DIMENSION STRN(99,3),STR(99,3),PSTR(99),PMSTR(99),TEMP(99)
      DIMENSION TR(20),ASF(20),SIGX(99),SIGMX(99)
      DIMENSION A(5),B(5)
      READ(5,141) (TEM(I),I=1,7)
      READ(5,141) (ALPHA(I),I=1,7)
      READ(5,141) (TR(I),I=1,7)
      READ(5,141) (ASF(I),I=1,7)
 141  FORMAT (7F8.3)
      I=0
 1    READ(5,190) PASS
 190  FORMAT (I5)
```

```
      WRITE(7,190) I
      I=-1
      IF (PASS .EQ. 0.0) GO TO 999
      WRITE(6,142) PASS
142   FORMAT(' PASS=',I5//)
      WRITE (7,190) PASS
11    READ (5,150) TIME,(T(K),K=1,J),((S(K,L),L=1,3),K=1,J)
150   FORMAT (F8.0,12F6.2)
      IF (T(1) .EQ. 0.0) GO TO 1
      I=I+1
      IF (TIME .GT. 0.0 .OR. PASS .GT. 1)  GO TO 3
      DO 6 II=1,J
      TZERO(II)=T(II)
      DO 7 KK=1,3
7     SZERO(II,KK)=S(II,KK)
6     CONTINUE
3     DO 8 JJ=1,J
      R=T(JJ)-TZERO(JJ)
      T(JJ)=(95.4*R)+72.2
      TEMP(JJ)=(T(JJ)/1000.)+1.
13    ASTR=FILLIN(T(JJ),TR,ASF,7)
      ALPH=FILLIN(T(JJ),TEM,ALPHA,7)-ALPH1
      DO 9 KK=1,3
      STRN(JJ,KK)=((S(JJ,KK)-SZERO(JJ,KK))*(-1000.))-ASTR
9     STR(JJ,KK)=STRN(JJ,KK)-((T(JJ)-72.2)*(ALPH))
      SIGX(JJ)=STR(JJ,1)+STR(JJ,3)-STR(JJ,2)
      SX=SIGX(1)/1000.
      PSTR(JJ)=MOHR(STR(JJ,1),STR(JJ,2),STR(JJ,3))
8     PMSTR(JJ)=PSTR(JJ)/1000.
      WRITE(6,170) TIME,(T(K),K=1,J),((STR(K,L),K=1,J),L=1,3),(SIGX(K),K
     1=1,J),(PSTR(K),K=1,J)
170   FORMAT (1X,F8.2/' TEMPERATURE',9X,3(F10.2,6X)/' STRAIN A. (MECH.)
     1',3X,3(F10.2,6X)/' STRAIN B.    "',6X,3(F10.2,6X)/' STRAIN C.    "
     1',6X,3(F10.2,6X)/' LONG. STRN. "',6X.3(F10.2,6X)/' PRINC. STRN. "
     1',6X,3(F10.2,6X)//)
      GO TO 11
```

```
 999  CALL EXIT
      END

      REAL FUNCTION MOHR(A,B,C)
C     *** MOHR *** ROSETTE ANALYSIS
C     FINDS PRINCIPLE STRAIN FROM THREE 45 DEG. STRAIN GAGE READINGS
C     A = 0 DEG. STRAIN READING
C     B = 45 DEG. STRAIN READING
C     C = 90 DEG. STRAIN READING
      SUM=A+C
      DIF=A-C
      SQR=(2. * B)-SUM
      ROOT=SQRT((DIF*DIF)+(SQR*SQR))
      U=SUM/2.
      W=ROOT/2.
      SIGMA1=U+W
      SIGMA2=U-W
      SIG1=ABS(SIGMA1)
      SIG2=ABS(SIGMA2)
      IF (SIG1-SIG2) 60,70,70
 60   P=SIGMA2
      GO TO 2
 70   P=SIGMA1
 2    MOHR=P
      RETURN
      END

      FUNCTION FILLIN(X,AB,OR,NO)
C     *** FILLIN ***  PARABOLIC INTERPOLATION
C     FINDS Y(X) FROM TABLE OF
C     AB(N) AND OR(N) CONTAINING NO POINTS.
      DIMENSION AB(NO),OR(NO)
      ANTRA(X1,X2,X3,X,Y1,Y2,Y3)=Y1*(X-X2)*(X-X3)/((X1-X2)*(X1-X3))+
     1 Y2*(X-X1)*(X-X3)/((X2-X1)*(X2-X3))+Y3*(X-X1)*(X-X2)/((X3-X1)*
     2 (X3-X2))
      IF(X-AB(1))  1,3,2
```

```
3     Y=OR(1)
      GO TO 99
1     Y=ANTRA(AB(1),AB(2),AB(3),X,OR(1),OR(2),OR(3))
      GO TO 99
2     IF(X-AB(2))1,6,5
6     Y=OR(2)
      GO TO 99
5     DO 7 I=3,NO
      M=I
      IF(X-AB(I))8,9,7
9     Y=OR(I)
      GO TO 99
7     CONTINUE
8     Y=ANTRA(AB(M-2),AB(M-1),AB(M),X,OR(M-2),OR(M-1),OR(M))
99    FILLIN=Y
      RETURN
      END

$ENTRY
C     INPUT DATA CARDS
  HY-130 .750GMA     BUTT WELD         8DCRP   28. 290. 14.      3   6.5
  70.     200.     300.     400.     500.     600.     800.
   6.47    6.6      6.71     6.8      6.9      6.96     7.06
  72.2    100.     150.     225.     275.     325.     400.
   0.       5.    -22.5    -97.    -128.    -129.     -90.
C     STRAIN AND TEMPERATURE READINGS FROM VISICORDER
    1
0.      4.93  5.01  5.14  8.07  8.29  8.45  7.47  7.67  7.86  8.67  8.86  9.09
C     ETC.
```

APPENDIX B

TABULATED DATA

WELDING STRAIN-TEMPERATURE VARIATION, EXPERIMENTAL RESULTS

METAL=MILD STEEL
THKSS(IN)=0.250
WELD PROCESS=GMA
WELD TYPE=BEAD-ON-PLATE
NO.PASSES= 1
CURRENT=DCRP
ARC VOLTAGE= 30.
AMPS= 280.
SPEED OF TRAVEL (IPM)= 24.0

WELD LINE

H T — THERMOCOUPLE

→/| A B C — STRAIN ROSETTES

TRANSVERSE DISTANCE FROM WELD.

TIME	1.00	2.50	1.00 (BACK)
PASS= 1			
0.00			
TEMPERATURE	72.26	72.26	72.26
STRAIN A. (MECH.)	14.53	14.53	14.53
STRAIN B. "	14.53	14.53	14.53
STRAIN C. "	14.53	14.53	14.53
PRINC. STRN. "	14.53	14.53	14.53
1.00			
TEMPERATURE	72.26	72.26	72.26
STRAIN A. (MECH.)	14.53	14.53	14.53
STRAIN B. "	14.53	14.53	14.53
STRAIN C. "	14.53	14.53	14.53
PRINC. STRN. "	14.53	14.53	14.53
5.00			
TEMPERATURE	72.26	72.26	72.26
STRAIN A. (MECH.)	-45.47	14.53	14.53
STRAIN B. "	-105.47	14.53	14.53
STRAIN C. "	-105.47	14.53	14.53
PRINC. STRN. "	-117.90	14.53	14.53

WELDING STRAIN-TEMPERATURE VARIATION, EXPERIMENTAL RESULTS

METAL= HY-80 STEEL
THKSS(IN)=0.250
WELD PROCESS=GMA
WELD TYPE=BEAD-ON-PLATE
NO.PASSES= 1
CURRENT=DCRP
ARC VOLTAGE= 30.
AMPS= 280.
SPEED OF TRAVEL (IPM)= 24.0

WELD LINE

H T — THERMOCOUPLE

→/| A B C — STRAIN ROSETTES

TRANSVERSE DISTANCE FROM WELD.

TIME	1.00	2.50
PASS= 1		
0.00		
TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	14.56	14.56
STRAIN B. "	14.56	14.56
STRAIN C. "	14.56	14.56
PRINC. STRN. "	14.56	14.56
1.00		
TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	14.56	14.56
STRAIN B. "	14.56	14.56
STRAIN C. "	14.56	14.56
PRINC. STRN. "	14.56	14.56
3.00		
TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	14.56	14.56
STRAIN B. "	14.56	14.56
STRAIN C. "	-45.44	14.56
PRINC. STRN. "	-57.66	14.56

10.00 (ARC PASSES GAGE LOCATION)

TEMPERATURE	72.26	72.26	72.26
STRAIN A. (MECH.)	-45.47	14.53	-285.47
STRAIN B. "	-165.47	14.53	-475.47
STRAIN C. "	-45.47	14.53	344.53
PRINC. STRN. "	-165.47	14.53	566.6[illegible]

11.00

TEMPERATURE	92.57	77.43	82.57
STRAIN A. (MECH.)	-53.52	7.15	-239.52
STRAIN B. "	-233.52	7.15	-533.52
STRAIN C. "	-53.52	67.15	21[illegible].4[illegible]
PRINC. STRN. "	-239.52	79.58	-585.71

12.00

TEMPERATURE	87.68	67.[illegible]6	72.26
STRAIN A. (MECH.)	-125.52	22.65	-1[illegible]5.47
STRAIN B. "	-305.53	22.65	-765.47
STRAIN C. "	-5.52	82.65	44.53
PRINC. STRN. "	-312.91	95.[illegible]8	-763.29

13.00

TEMPERATURE	92.76	72.26	82.57
STRAIN A. (MECH.)	-31[illegible].88	-45.47	12[illegible].42
STRAIN B. "	-37[illegible].89	14.53	-830.53
STRAIN C. "	43.11	74.53	-259.52
PRINC. STRN. "	-43[illegible].93	74.53	-922.25

14.00

TEMPERATURE	132.83	72.26	92.76
STRAIN A. (MECH.)	-559.82	-45.47	249.11
STRAIN B. "	-379.83	14.53	-730.80
STRAIN C. "	160.18	74.53	-467.80
PRINC. STRN. "	-692.32	74.53	-984.42

16.00

TEMPERATURE	149.99	72.26	151.4
STRAIN A. (MECH.)	-1054.08	-45.47	2[illegible]3.47
STRAIN B. "	-394.08	44.53	-576.53
STRAIN C. "	265.92	1[illegible]4.53	-546.53
PRINC. STRN. "	-1[illegible]54.08	1[illegible]6.01	-723.43

17.00

TEMPERATURE	205.76	77.43	156.90
STRAIN A. (MECH.)	-1291.33	-52.95	94.87
STRAIN B. "	-441.33	67.15	-445.13
STRAIN C. "	339.67	127.15	-535.12
PRINC. STRN. "	-1281.88	132.02	-6[illegible]7.23

5.00

TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	14.56	14.56
STRAIN B. "	14.56	14.56
STRAIN C. "	-105.44	14.56
PRINC. STRN. "	-130.25	14.56

6.00

TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	-15.44	14.56
STRAIN B. "	14.56	14.56
STRAIN C. "	-105.44	14.56
PRINC. STRN. "	-219.47	14.56

7.00

TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	-15.44	14.56
STRAIN B. "	44.56	74.56
STRAIN C. "	-165.44	14.56
PRINC. STRN. "	-244.67	74.56

8.00

TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	-15.44	14.56
STRAIN B. "	74.56	74.56
STRAIN C. "	-165.44	74.56
PRINC. STRN. "	-271.68	66.55

9.00

TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	-15.44	44.56
STRAIN B. "	134.56	74.56
STRAIN C. "	-165.44	74.56
PRINC. STRN. "	-327.61	80.77

10.00

TEMPERATURE	72.26	72.26
STRAIN A. (MECH.)	-15.44	44.56
STRAIN B. "	254.56	134.56
STRAIN C. "	-165.44	74.56
PRINC. STRN. "	-443.50	136.04

11.00

TEMPERATURE	77.43	72.26
STRAIN A. (MECH.)	-20.25	14.56
STRAIN B. "	305.75	154.56
STRAIN C. "	-50.24	74.56
PRINC. STRN. "	-440.52	157.53

19.00			
TEMPERATURE	255.84	77.43	255.84
STRAIN A. (MECH.)	-1618.44	-52.85	-238.44
STRAIN B. "	-538.44	97.15	-238.44
STRAIN C. "	301.56	157.15	-388.44
PRINC. STRN. "	-1625.91	166.39	-419.59
20.00			
TEMPERATURE	275.45	82.57	279.28
STRAIN A. (MECH.)	-1731.98	-59.52	-411.[illegible]8
STRAIN B. "	-531.98	120.48	-2[illegible]1.[illegible]7
STRAIN C. "	308.02	180.48	-291.[illegible]8
PRINC. STRN. "	-1747.74	194.64	-517.63
22.00			
TEMPERATURE	309.88	77.43	315.99
STRAIN A. (MECH.)	-1848.44	-82.85	-888.8[illegible]
STRAIN B. "	-768.44	127.15	-198.79
STRAIN C. "	251.56	127.15	-198.8[illegible]
PRINC. STRN. "	-1848.87	172.64	-1031.7[illegible]
24.00			
TEMPERATURE	336.57	87.68	349.7[illegible]
STRAIN A. (MECH.)	-1913.55	-65.53	-1289.91
STRAIN B. "	-1073.55	114.43	-299.9[illegible]
STRAIN C. "	126.45	114.48	-149.91
PRINC. STRN. "	-1929.31	151.76	-1427.93
26.00			
TEMPERATURE	356.09	87.68	368.50
STRAIN A. (MECH.)	-1984.06	-95.52	-1514.29
STRAIN B. "	-1204.06	114.48	-254.29
STRAIN C. "	115.94	114.48	-14.29
PRINC. STRN. "	-2018.22	157.97	-1671.26
30.00			
TEMPERATURE	377.51	97.81	391.97
STRAIN A. (MECH.)	-2183.62	-135.64	-1932.20
STRAIN B. "	-1583.62	44.35	-222.20
STRAIN C. "	156.38	44.36	107.80
PRINC. STRN. "	-2315.08	-172.92	-2143.67
40.00			
TEMPERATURE	405.59	127.48	415.99
STRAIN A. (MECH.)	-2364.31	-273.19	-2274.29
STRAIN B. "	-1744.31	-33.19	-204.29
STRAIN C. "	295.69	26.81	245.71
PRINC. STRN. "	-2527.90	-298.12	-2512.19

12.00		
TEMPERATURE	92.76	72.26
STRAIN A. (MECH.)	-60.72	14.56
STRAIN B. "	475.28	154.56
STRAIN C. "	115.28	134.56
PRINC. STRN. "	468.15	206.73
13.00		
TEMPERATURE	92.76	72.26
STRAIN A. (MECH.)	-150.72	14.56
STRAIN B. "	475.28	154.56
STRAIN C. "	255.28	154.56
PRINC. STRN. "	537.58	231.34
14.00		
TEMPERATURE	114.78	72.26
STRAIN A. (MECH.)	-336.63	14.56
STRAIN B. "	413.36	254.56
STRAIN C. "	353.37	254.56
PRINC. STRN. "	540.35	304.27
15.00		
TEMPERATURE	141.52	72.26
STRAIN A. (MECH.)	-451.56	-45.44
STRAIN B. "	358.04	254.56
STRAIN C. "	478.04	254.56
PRINC. STRN. "	592.05	316.65
16.00		
TEMPERATURE	165.35	72.26
STRAIN A. (MECH.)	-555.10	-105.44
STRAIN B. "	310.65	254.56
STRAIN C. "	550.85	314.56
PRINC. STRN. "	-642.26	362.63
17.00		
TEMPERATURE	188.11	72.26
STRAIN A. (MECH.)	-721.01	-105.44
STRAIN B. "	208.55	154.56
STRAIN C. "	368.55	374.56
PRINC. STRN. "	-181.17	381.55
18.00		
TEMPERATURE	205.76	72.26
STRAIN A. (MECH.)	-764.32	-105.44
STRAIN B. "	165.68	154.56
STRAIN C. "	985.68	374.56
PRINC. STRN. "	-810.88	381.55

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   50.00
TEMPERATURE            419.23        169.99        419.51
STRAIN A. (MECH.)    -2289.12       -454.18      -2249.57
STRAIN B.    "       -1629.12        -64.8       -2 [illegible].57
STRAIN C.    "         321.88         25.02        362.43
PRINC. STRN. "       -2439.91       -457.10      -2442.32

   70.00
TEMPERATURE            386.24        214.43        394.71
STRAIN A. (MECH.)    -1954.33       -677.34      -2 26.35
STRAIN B.    "       -1444.33       -137.34       -166.35
STRAIN C.    "         395.67        162.66        283.65
PRINC. STRN. "       -2127.64       -694.15      -2224.51

   90.00
TEMPERATURE            369.50        235.49        374.54
STRAIN A. (MECH.)    -1754.29       -817.32      -192[illegible].36
STRAIN B.    "       -1394.29       -187.32       -2[illegible].35
STRAIN C.    "         405.71        172.68        140.64
PRINC. STRN. "       -1972.20       -835.41      -1993.[illegible]

   240.00
TEMPERATURE            247.79        218.68        255.84
STRAIN A. (MECH.)     -631.76       -735.32       -608.44
STRAIN B.    "        -871.76       -135.32          1.56
STRAIN C.    "         413.24        254.68        -59.44
PRINC. STRN. "       -1034.58       -746.33      -1224.76

10000.00
TEMPERATURE             77.43         82.57         77.43
STRAIN A. (MECH.)      127.15         60.48       -232.45
STRAIN B.    "        -532.85        330.88        427.15
STRAIN C.    "         367.15        390.48        127.15
PRINC. STRN. "        1006.69        421.35       -545.49

COMPILE TIME=     0.73 SEC.EXECUTION TIME=     1.91 SEC.OBJECT CODE=

   15.00
TEMPERATURE            231.34         72.00
STRAIN A. (MECH.)     -913.56       -105.44
STRAIN B.    "         132.04        234.56
STRAIN C.    "         614.04        374.56
PRINC. STRN. "        -969.32        422.[illegible]

   20.00
TEMPERATURE            343.19         72.00
STRAIN A. (MECH.)    -1020.72       -105.44
STRAIN B.    "          89.28        134.56
STRAIN C.    "         635.28        374.56
PRINC. STRN. "       -1057.54        376.2[illegible]

   22.00
TEMPERATURE            279.28         72.20
STRAIN A. (MECH.)    -1170.08       -[illegible].44
STRAIN B.    "        -120.08         74.56
STRAIN C.    "         655.54        374.56
PRINC. STRN. "       -1179.97        353.[illegible]

   24.00
TEMPERATURE            305.58         72.20
STRAIN A. (MECH.)    -1327.44       -105.44
STRAIN B.    "        -157.42         14.56
STRAIN C.    "         564.78        314.56
PRINC. STRN. "       -1353.63        333.03

   26.00
TEMPERATURE            326.40         72.20
STRAIN A. (MECH.)    -1377.30         14.56
STRAIN B.    "        -267.30        -45.44
STRAIN C.    "         512.70        254.56
PRINC. STRN. "       -1391.59        350.[illegible]

   28.00
TEMPERATURE            343.19         72.20
STRAIN A. (MECH.)    -1491.51         14.56
STRAIN B.    "        -321.51         14.56
STRAIN C.    "         456.49        254.56
PRINC. STRN. "       -1510.82        304.27

   30.00
TEMPERATURE            352.91         72.26
STRAIN A. (MECH.)    -1610.09         44.56
STRAIN B.    "        -330.09        -45.44
STRAIN C.    "         399.91        254.56
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PRINC. STRN. "          -1634.57           371.03

   40.00
TEMPERATURE              386.24            82.57
STRAIN A. (MECH.)      -1518.06            35.63
STRAIN B.     "         -568.06          -114.37
STRAIN C.     "          331.54           125.63
PRINC. STRN. "         -1540.34           280.15

   50.00
TEMPERATURE              402.91           112.78
STRAIN A. (MECH.)      -2050.71           -66.63
STRAIN B.     "         -640.71          -186.63
STRAIN C.     "          349.29           113.37
PRINC. STRN. "         -2068.55           251.84

   60.00
TEMPERATURE              405.59           132.32
STRAIN A. (MECH.)      -2053.34          -125.04
STRAIN B.     "         -583.35          -185.04
STRAIN C.     "          376.66           114.96
PRINC. STRN. "         -2079.81          -221.37

   70.00
TEMPERATURE              402.91           151.40
STRAIN A. (MECH.)      -1930.71          -237.61
STRAIN B.     "         -580.71          -177.61
STRAIN C.     "          439.29           122.39
PRINC. STRN. "         -1942.14          -273.94

   80.00
TEMPERATURE              394.71           169.99
STRAIN A. (MECH.)      -1923.69          -285.82
STRAIN B.     "         -573.70          -225.83
STRAIN C.     "          506.30           194.17
PRINC. STRN. "         -1931.17          -345.82

   90.00
TEMPERATURE              386.24           179.11
STRAIN A. (MECH.)      -1758.06          -428.72
STRAIN B.     "         -506.06          -278.72
STRAIN C.     "          511.94           201.28
PRINC. STRN. "         -1805.92          -469.32

                       GAGE FAILURE
  100.00
TEMPERATURE              380.45           196.59
STRAIN A. (MECH.)      15304.89          -472.83
STRAIN B.     "        14734.89          -322.83
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STRAIN C.    "        14314.65        277.17
PRINC. STRN. "        15310.54       -535.16

  350.00
TEMPERATURE             343.15        214.40
STRAIN A. (MECH.)     15308.45       -605.60
STRAIN B.    "        14738.45       -305.60
STRAIN C.    "        14318.45        254.40
PRINC. STRN. "        15314.14       -638.24

  450.00
TEMPERATURE             322.56        222.53
STRAIN A. (MECH.)     15301.04       -536.16
STRAIN B.    "        14731.03       -296.78
STRAIN C.    "        14311.04        363.22
PRINC. STRN. "        15306.66       -563.36

  600.00
TEMPERATURE             196.59        179.11
STRAIN A. (MECH.)     15187.16       -216.72
STRAIN B.    "        14617.16       -126.72
STRAIN C.    "        14197.16        411.26
PRINC. STRN. "        15192.81        463.28

  900.00
TEMPERATURE             165.35        151.40
STRAIN A. (MECH.)     15160.85       -177.61
STRAIN B.    "        14590.85        -67.61
STRAIN C.    "        14170.85        352.35
PRINC. STRN. "        15166.54        452.72

10000.00
TEMPERATURE              92.76         87.66
STRAIN A. (MECH.)     15149.26         92.15
STRAIN B.    "        14579.27        152.15
STRAIN C.    "        14159.26        422.15
PRINC. STRN. "        15154.53        452.72

COMPILE TIME=    0.63 SEC,EXECUTION TIME=    1.11 SEC,OBJECT CO
COMPILE TIME=    0.03 SEC,EXECUTION TIME=    0.0  SEC,OBJECT CO
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0.750 INCH HY-80 STEEL (CONTINUED)

WELDING STRAIN-TEMPERATURE VARIATION. EXPERIMENTAL RESULTS

METAL. HY-80 STEEL
THKSS(IN)=0.750
WELD PROCESS=GMA
WELD TYPE=BUTT WELD
NO.PASSES= 18
CURRENT=DCRP
ARC VOLTAGE= 28.
AMPS= 290.
SPEED OF TRAVEL (IPM)= 20.0

WELD EDGE

THERMO-COUPLES T

STRAIN ROSETTES A B C

TRANSVERSE DISTANCE FROM WELD.

PASS= 1

TIME	0.5	1.7	2.7
0.00			
TEMPERATURE	72.20	72.20	72.20
STRAIN A. (MECH.)	-0.00	-0.00	-0.00
STRAIN B. "	-0.00	-0.00	-0.00
STRAIN C. "	-0.00	-0.00	-0.00
LONG. STRN. "	-0.00	0.00	0.00
PRINC. STRN. "	0.00	0.00	0.00
1.00			
TEMPERATURE	143.75	139.93	138.03
STRAIN A. (MECH.)	-1733.68	57.36	25.41
STRAIN B. "	-1786.45	-67.64	-54.59
STRAIN C. "	-1733.68	-2.64	55.41
LONG. STRN. "	-1786.45	117.36	135.41
PRINC. STRN. "	-1797.38	122.23	136.59
3.00			
TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1733.68	36.38	14.46
STRAIN B. "	-1786.45	-73.62	-45.54
STRAIN C. "	-1733.68	6.38	74.46
LONG. STRN. "	-1786.45	116.39	134.46
PRINC. STRN. "	-1797.38	117.55	139.33
5.00			
TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1765.34	16.38	4.46
STRAIN B. "	-1754.79	-93.62	-45.54
STRAIN C. "	-1723.13	46.38	104.46
LONG. STRN. "	-1754.79	156.38	154.46
PRINC. STRN. "	-1797.38	157.27	166.27
7.00			
TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1775.90	-13.62	-5.54
STRAIN B. "	-1754.79	-73.62	-25.54
STRAIN C. "	-1733.68	86.38	114.46
LONG. STRN. "	-1754.79	146.38	134.46
PRINC. STRN. "	-1798.72	157.21	154.46
9.00			
TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1744.24	-3.62	4.46
STRAIN B. "	-1754.79	-13.62	14.46
STRAIN C. "	-1712.57	106.38	124.46
LONG. STRN. "	-1754.79	116.38	114.46
PRINC. STRN. "	-1786.83	136.52	142.57
10.00 (ARC)			
TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1723.13	-3.62	14.46
STRAIN B. "	-1744.24	6.38	24.46
STRAIN C. "	-1670.36	116.38	134.46
LONG. STRN. "	-1744.24	136.38	124.46
PRINC. STRN. "	-1797.88	134.48	152.57
11.00			
TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1680.91	16.38	24.46
STRAIN B. "	-1680.91	36.38	44.46
STRAIN C. "	-1564.82	136.38	124.46
LONG. STRN. "	-1680.91	86.38	104.46
PRINC. STRN. "	-1797.01	112.86	132.77
12.00			
TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1628.14	36.38	34.46
STRAIN B. "	-1522.60	56.38	64.46
STRAIN C. "	-1459.28	106.38	124.46
LONG. STRN. "	-1522.60	86.38	94.46
PRINC. STRN. "	-1732.90	109.46	126.99

13.00

TEMPERATURE	143.75	138.98	137.07
STRAIN A. (MECH.)	-1501.49	76.38	54.46
STRAIN B. "	-1374.84	86.38	84.46
STRAIN C. "	-1205.98	96.38	124.46
LONG. STRN. "	-1374.84	86.38	94.46
PRINC. STRN. "	-1678.84	94.38	124.82

14.00

TEMPERATURE	150.43	138.98	137.07
STRAIN A. (MECH.)	-1536.26	96.38	74.46
STRAIN B. "	-1367.40	106.38	104.46
STRAIN C. "	-1166.87	76.38	124.46
LONG. STRN. "	-1367.40	66.38	94.46
PRINC. STRN. "	-1749.03	108.74	124.96

15.00

TEMPERATURE	155.20	138.98	137.07
STRAIN A. (MECH.)	-1445.01	146.38	104.46
STRAIN B. "	-1139.94	106.38	124.46
STRAIN C. "	-983.63	56.38	114.46
LONG. STRN. "	-1139.94	96.38	94.46
PRINC. STRN. "	-1638.90	146.65	125.27

16.00

TEMPERATURE	159.97	138.98	137.07
STRAIN A. (MECH.)	-1279.89	186.38	124.46
STRAIN B. "	-910.50	106.38	124.46
STRAIN C. "	-836.62	36.38	104.46
LONG. STRN. "	-910.50	116.38	104.46
PRINC. STRN. "	-1412.96	186.54	128.60

17.00

TEMPERATURE	165.69	138.98	137.07
STRAIN A. (MECH.)	-1177.54	216.38	154.46
STRAIN B. "	-729.27	106.38	134.46
STRAIN C. "	-623.73	6.38	84.46
LONG. STRN. "	-729.27	116.38	104.46
PRINC. STRN. "	-1346.09	216.50	157.54

18.00

TEMPERATURE	172.37	138.98	137.07
STRAIN A. (MECH.)	-964.65	246.38	184.46
STRAIN B. "	-553.04	96.38	144.46
STRAIN C. "	-467.50	-3.62	84.46
LONG. STRN. "	-553.04	146.38	124.46
PRINC. STRN. "	-1132.06	248.85	185.45

20.00

TEMPERATURE	186.68	138.98	137.07
STRAIN A. (MECH.)	-670.05	306.38	244.46
STRAIN B. "	-374.54	56.38	144.46
STRAIN C. "	-363.98	-33.62	64.46
LONG. STRN. "	-374.54	216.38	164.46
PRINC. STRN. "	-738.85	324.26	245.02

22.00

TEMPERATURE	202.90	139.93	137.07
STRAIN A. (MECH.)	-617.86	327.36	284.46
STRAIN B. "	-259.02	17.36	134.46
STRAIN C. "	-164.03	-32.64	94.46
LONG. STRN. "	-259.02	277.36	204.46
PRINC. STRN. "	-766.30	369.39	289.67

24.00

TEMPERATURE	218.16	139.93	137.07
STRAIN A. (MECH.)	-487.06	327.36	314.46
STRAIN B. "	-360.42	-22.64	114.46
STRAIN C. "	-181.00	-12.64	64.46
LONG. STRN. "	-360.42	337.36	264.46
PRINC. STRN. "	-674.60	404.95	335.24

26.00

TEMPERATURE	229.61	140.89	137.07
STRAIN A. (MECH.)	-441.94	318.36	324.46
STRAIN B. "	-399.73	-51.64	104.46
STRAIN C. "	-135.88	-1.64	74.46
LONG. STRN. "	-399.73	368.36	294.46
PRINC. STRN. "	-706.57	422.36	356.46

28.00

TEMPERATURE	240.10	142.80	137.07
STRAIN A. (MECH.)	-432.51	300.40	334.46
STRAIN B. "	-529.17	-49.60	94.46
STRAIN C. "	-223.19	10.40	84.46
LONG. STRN. "	-529.17	363.47	324.46
PRINC. STRN. "	-716.71	406.50	379.31

32.00

TEMPERATURE	257.28	146.61	137.07
STRAIN A. (MECH.)	-439.39	284.70	334.46
STRAIN B. "	-768.23	-55.30	74.46
STRAIN C. "	-377.73	34.70	104.46
LONG. STRN. "	-768.23	374.70	364.46
PRINC. STRN. "	-865.84	408.40	404.53

36.00			
TEMPERATURE	269.68	150.43	138.03
STRAIN A. (MECH.)	-486.73	249.13	325.41
STRAIN B. "	-1035.04	-50.86	75.41
STRAIN C. "	-496.78	49.14	125.41
LONG. STRN. "	-1035.04	349.14	375.41
PRINC. STRN. "	-1141.31	372.74	405.69

40.00			
TEMPERATURE	278.26	155.20	138.03
STRAIN A. (MECH.)	-585.07	243.67	325.41
STRAIN B. "	-1239.42	-46.33	65.41
STRAIN C. "	-658.95	43.67	135.41
LONG. STRN. "	-1239.42	333.67	395.41
PRINC. STRN. "	-1326.02	358.37	420.80

45.00			
TEMPERATURE	284.94	160.92	138.98
STRAIN A. (MECH.)	-716.00	219.30	316.38
STRAIN B. "	-1486.44	-40.70	66.38
STRAIN C. "	-832.09	29.30	146.38
LONG. STRN. "	-1486.44	289.30	396.38
PRINC. STRN. "	-1571.14	314.69	416.98

50.00			
TEMPERATURE	288.76	168.55	139.93
STRAIN A. (MECH.)	-821.01	237.14	307.36
STRAIN B. "	-1644.23	-32.86	57.36
STRAIN C. "	-1033.43	17.14	137.36
LONG. STRN. "	-1644.23	257.14	387.36
PRINC. STRN. "	-1705.20	285.48	407.96

55.00			
TEMPERATURE	289.71	173.32	142.80
STRAIN A. (MECH.)	-970.05	202.22	300.40
STRAIN B. "	-1765.48	-27.78	60.40
STRAIN C. "	-1170.57	12.23	140.40
LONG. STRN. "	-1765.48	242.23	380.40
PRINC. STRN. "	-1823.84	272.30	399.29

60.00			
TEMPERATURE	289.71	179.05	144.70
STRAIN A. (MECH.)	-984.48	188.52	302.52
STRAIN B. "	-1849.91	-21.48	52.52
STRAIN C. "	-1296.11	-1.48	132.52
LONG. STRN. "	-1849.91	208.52	382.52
PRINC. STRN. "	-1898.65	242.69	403.12

70.00			
TEMPERATURE	288.76	188.59	149.47
STRAIN A. (MECH.)	-1222.06	179.47	288.10
STRAIN B. "	-2066.39	-0.53	48.10
STRAIN C. "	-1401.48	-10.53	128.10
LONG. STRN. "	-2066.39	169.47	368.10
PRINC. STRN. "	-2131.20	211.94	386.98

80.00			
TEMPERATURE	285.90	194.31	154.24
STRAIN A. (MECH.)	-1343.83	186.30	282.75
STRAIN B. "	-2167.05	26.30	72.75
STRAIN C. "	-1544.36	-13.70	132.75
LONG. STRN. "	-2167.05	146.30	342.75
PRINC. STRN. "	-2218.02	202.92	362.18

90.00			
TEMPERATURE	280.17	200.04	158.06
STRAIN A. (MECH.)	-1376.33	173.34	266.45
STRAIN B. "	-2178.44	33.34	76.45
STRAIN C. "	-1576.86	-26.66	126.45
LONG. STRN. "	-2178.44	113.34	316.45
PRINC. STRN. "	-2225.78	181.04	335.38

105.00			
TEMPERATURE	273.49	205.76	165.69
STRAIN A. (MECH.)	-1498.77	170.57	244.15
STRAIN B. "	-2216.45	50.57	94.15
STRAIN C. "	-1657.08	-29.43	114.15
LONG. STRN. "	-2216.45	90.57	264.15
PRINC. STRN. "	-2268.60	172.55	286.16

120.00			
TEMPERATURE	266.82	208.62	170.46
STRAIN A. (MECH.)	-1579.08	174.26	239.15
STRAIN B. "	-2233.43	64.26	109.15
STRAIN C. "	-1695.18	-35.74	109.15
LONG. STRN. "	-2233.43	74.26	239.15
PRINC. STRN. "	-2295.61	174.38	266.08

150.00			
TEMPERATURE	253.46	210.53	177.14
STRAIN A. (MECH.)	-1634.44	176.74	216.40
STRAIN B. "	-2141.04	66.74	116.40
STRAIN C. "	-1687.21	-43.26	86.40
LONG. STRN. "	-2141.04	66.74	186.40
PRINC. STRN. "	-2210.80	176.74	225.22

200.00			
TEMPERATURE	217.21	198.13	183.82

STRAIN A. (MECH.)	-1716.86	210.97	213.92
STRAIN B. "	-2033.49	60.97	143.92
STRAIN C. "	-1516.34	-19.03	63.92
LONG. STRN. "	-2033.49	130.97	133.92
PRINC. STRN. "	-2267.38	216.18	214.09

460.00

TEMPERATURE	194.31	182.86	175.23
STRAIN A. (MECH.)	-1828.76	212.83	204.30
STRAIN B. "	-2029.28	32.83	134.30
STRAIN C. "	-1712.66	-7.17	54.30
LONG. STRN. "	-2029.28	172.83	124.30
PRINC. STRN. "	-2167.48	233.22	204.47

530.00

TEMPERATURE	186.68	178.09	173.32
STRAIN A. (MECH.)	-1799.34	207.46	202.22
STRAIN B. "	-1799.34	27.46	132.22
STRAIN C. "	-1662.13	-12.54	52.22
LONG. STRN. "	-1799.34	167.46	122.22
PRINC. STRN. "	-1936.54	227.84	202.39

640.00

TEMPERATURE	180.00	172.37	169.51
STRAIN A. (MECH.)	-1827.73	211.20	218.14
STRAIN B. "	-1806.63	21.20	128.14
STRAIN C. "	-1711.64	1.20	58.14
LONG. STRN. "	-1806.63	191.20	148.14
PRINC. STRN. "	-1923.25	241.29	218.76

880.00

TEMPERATURE	167.60	161.88	161.88
STRAIN A. (MECH.)	-1794.63	210.26	210.26
STRAIN B. "	-1699.64	10.26	120.26
STRAIN C. "	-1646.87	10.26	60.26
LONG. STRN. "	-1699.64	210.26	150.26
PRINC. STRN. "	-1858.08	251.68	211.74

1030.00

TEMPERATURE	161.88	157.11	158.06
STRAIN A. (MECH.)	-1733.12	205.52	216.45
STRAIN B. "	-1690.90	5.52	106.45
STRAIN C. "	-1648.68	5.52	46.45
LONG. STRN. "	-1690.90	205.52	156.45
PRINC. STRN. "	-1778.76	246.94	220.05

PASS= 2

0.00

TEMPERATURE	159.01	154.24	155.20
STRAIN A. (MECH.)	-1718.19	242.75	223.66
STRAIN B. "	-1749.86	-57.25	13.67
STRAIN C. "	-1633.76	-47.25	23.67
LONG. STRN. "	-1749.86	252.75	233.66
PRINC. STRN. "	-1835.53	310.00	272.32

1.00

TEMPERATURE	159.01	154.24	155.20
STRAIN A. (MECH.)	-1728.75	232.75	223.66
STRAIN B. "	-1760.41	-67.25	13.67
STRAIN C. "	-1633.76	-47.25	33.67
LONG. STRN. "	-1760.41	252.75	243.66
PRINC. STRN. "	-1856.52	305.35	277.83

3.00

TEMPERATURE	159.01	154.24	155.20
STRAIN A. (MECH.)	-1739.30	272.75	213.66
STRAIN B. "	-1760.41	-87.25	3.67
STRAIN C. "	-1602.10	-47.25	43.67
LONG. STRN. "	-1760.41	262.75	253.66
PRINC. STRN. "	-1897.99	308.77	279.83

6.00

TEMPERATURE	159.01	154.24	155.20
STRAIN A. (MECH.)	-1770.96	192.75	183.66
STRAIN B. "	-1749.86	-117.25	3.67
STRAIN C. "	-1507.11	2.75	93.67
LONG. STRN. "	-1749.86	312.75	273.66
PRINC. STRN. "	-2013.93	332.80	280.97

8.00

TEMPERATURE	159.01	154.24	155.20
STRAIN A. (MECH.)	-1792.07	182.75	183.66
STRAIN B. "	-1633.76	-97.25	23.66
STRAIN C. "	-1443.79	52.75	123.67
LONG. STRN. "	-1633.76	332.75	283.66
PRINC. STRN. "	-1993.45	342.36	287.08

9.00

TEMPERATURE	159.01	154.24	155.20
STRAIN A. (MECH.)	-1781.52	182.75	183.66
STRAIN B. "	-1538.77	-77.25	33.67
STRAIN C. "	-1401.57	62.75	123.67
LONG. STRN. "	-1538.77	322.75	273.66
PRINC. STRN. "	-1945.79	331.55	277.36

10.00 (ARC)

TEMPERATURE	159.01	154.24	155.20
STRAIN A. (MECH.)	-1728.75	182.75	193.66

STRAIN B. "	-1391.02	-47.25	43.67
STRAIN C. "	-1348.80	192.75	133.67
LONG. STRN. "	-1391.02	332.75	283.67
PRINC. STRN. "	-1830.20	336.91	287.36
11.00			
TEMPERATURE	159.97	154.24	155.20
STRAIN A. (MECH.)	-1649.29	192.75	203.67
STRAIN B. "	-1206.02	-7.25	63.66
STRAIN C. "	-1237.68	122.75	143.67
LONG. STRN. "	-1206.02	322.75	283.67
PRINC. STRN. "	-1719.56	326.42	287.68
12.00			
TEMPERATURE	159.97	154.24	155.20
STRAIN A. (MECH.)	-1311.56	212.75	213.66
STRAIN B. "	-910.50	22.75	83.67
STRAIN C. "	-942.16	122.75	153.67
LONG. STRN. "	-910.50	312.75	283.66
PRINC. STRN. "	-1373.19	319.57	288.07
13.00			
TEMPERATURE	168.55	154.24	155.20
STRAIN A. (MECH.)	-1282.46	252.75	223.66
STRAIN B. "	-828.63	42.75	93.67
STRAIN C. "	-828.63	132.75	153.67
LONG. STRN. "	-828.63	342.75	283.66
PRINC. STRN. "	-1376.45	354.30	289.91
14.00			
TEMPERATURE	174.28	154.24	155.20
STRAIN A. (MECH.)	-1037.94	282.75	253.67
STRAIN B. "	-510.23	62.75	193.66
STRAIN C. "	-563.00	122.75	143.67
LONG. STRN. "	-510.23	342.75	293.67
PRINC. STRN. "	-1111.98	363.99	308.44
16.00			
TEMPERATURE	187.63	154.24	155.20
STRAIN A. (MECH.)	-537.84	312.75	273.66
STRAIN B. "	53.19	82.75	133.67
STRAIN C. "	-157.90	112.75	143.67
LONG. STRN. "	53.19	342.75	283.66
PRINC. STRN. "	-549.66	376.76	307.91
17.00			
TEMPERATURE	197.17	154.24	155.20

STRAIN A. (MECH.)	-429.51	342.75	283.66
STRAIN B. "	-7.36	92.75	143.66
STRAIN C. "	-28.46	102.75	153.67
LONG. STRN. "	-7.36	352.75	293.67
PRINC. STRN. "	-502.41	399.66	317.91
19.00			
TEMPERATURE	215.30	155.20	155.20
STRAIN A. (MECH.)	-187.03	393.66	323.66
STRAIN B. "	192.92	73.67	143.66
STRAIN C. "	150.70	83.67	143.67
LONG. STRN. "	192.92	403.66	323.67
PRINC. STRN. "	243.62	465.05	360.94
21.00			
TEMPERATURE	232.47	156.15	156.15
STRAIN A. (MECH.)	-45.47	394.59	354.59
STRAIN B. "	69.07	44.59	144.59
STRAIN C. "	281.71	84.59	144.59
LONG. STRN. "	69.07	434.59	354.59
PRINC. STRN. "	286.73	488.69	398.08
24.00			
TEMPERATURE	253.46	157.11	156.15
STRAIN A. (MECH.)	-30.22	375.52	364.59
STRAIN B. "	-19.67	5.52	134.59
STRAIN C. "	296.96	75.52	144.59
LONG. STRN. "	-19.67	445.52	374.59
PRINC. STRN. "	-346.89	491.79	417.38
26.00			
TEMPERATURE	266.82	159.01	156.15
STRAIN A. (MECH.)	-80.60	357.40	364.59
STRAIN B. "	-217.69	-12.60	134.59
STRAIN C. "	204.56	87.40	154.59
LONG. STRN. "	-217.69	457.40	384.59
PRINC. STRN. "	-509.16	493.41	422.84
30.00			
TEMPERATURE	284.94	162.83	156.15
STRAIN A. (MECH.)	-103.86	321.22	374.59
STRAIN B. "	-494.36	-28.78	124.59
STRAIN C. "	65.01	101.22	174.59
LONG. STRN. "	-494.36	451.22	424.59
PRINC. STRN. "	-712.28	475.23	454.87
34.00			
TEMPERATURE	297.34	167.60	156.15
STRAIN A. (MECH.)	-202.54	286.14	364.59

STRAIN B. =	-761.91	-33.86	104.59
STRAIN C. =	-86.45	106.14	184.59
LONG. STRN. =	-761.91	426.14	444.59
PRINC. STRN. =	-966.85	443.12	466.94
40.00			
TEMPERATURE	309.75	176.19	157.11
STRAIN A. (MECH.)	-406.57	235.35	355.52
STRAIN B. =	-1177.02	-24.65	95.52
STRAIN C. =	-522.67	105.35	205.52
LONG. STRN. =	-1177.02	365.35	465.52
PRINC. STRN. =	-1261.72	375.89	480.14
46.00			
TEMPERATURE	311.65	183.82	158.06
STRAIN A. (MECH.)	-480.17	203.92	336.45
STRAIN B. =	-1335.05	-16.08	96.45
STRAIN C. =	-617.37	93.92	206.45
LONG. STRN. =	-1335.05	313.92	446.45
PRINC. STRN. =	-1424.28	322.85	458.13
52.00			
TEMPERATURE	315.47	191.45	160.92
STRAIN A. (MECH.)	-732.93	192.86	319.30
STRAIN B. =	-1640.58	2.86	99.30
STRAIN C. =	-975.67	82.86	219.30
LONG. STRN. =	-1640.58	272.86	439.30
PRINC. STRN. =	-1687.26	283.64	446.52
62.00			
TEMPERATURE	314.52	199.08	164.74
STRAIN A. (MECH.)	-907.29	192.15	313.17
STRAIN B. =	-1825.40	22.15	103.17
STRAIN C. =	-1255.48	72.15	213.17
LONG. STRN. =	-1825.40	242.15	423.17
PRINC. STRN. =	-1838.59	257.45	430.80
70.00			
TEMPERATURE	311.65	207.67	169.51
STRAIN A. (MECH.)	-1113.41	193.02	308.14
STRAIN B. =	-2031.62	33.02	108.14
STRAIN C. =	-1398.38	43.02	188.14
LONG. STRN. =	-2031.62	203.02	388.14
PRINC. STRN. =	-2063.53	231.38	400.46
80.00			
TEMPERATURE	306.88	215.30	175.23
STRAIN A. (MECH.)	-1267.15	183.05	284.30
STRAIN B. =	-2153.69	53.05	114.30
STRAIN C. =	-1552.11	23.05	184.30
LONG. STRN. =	-2153.69	153.05	354.30
PRINC. STRN. =	-2181.11	197.39	364.30
95.00			
TEMPERATURE	299.25	221.98	181.91
STRAIN A. (MECH.)	-1479.37	192.10	281.75
STRAIN B. =	-2260.37	72.10	131.75
STRAIN C. =	-1701.00	12.10	161.75
LONG. STRN. =	-2260.37	132.10	311.75
PRINC. STRN. =	-2295.32	196.96	329.91
110.00			
TEMPERATURE	289.71	224.84	186.68
STRAIN A. (MECH.)	-1512.18	196.05	267.23
STRAIN B. =	-2219.31	86.05	147.23
STRAIN C. =	-1712.71	6.05	157.23
LONG. STRN. =	-2219.31	116.05	277.23
PRINC. STRN. =	-2251.00	197.23	297.38
120.00			
TEMPERATURE	283.99	226.75	190.53
STRAIN A. (MECH.)	-1523.51	197.84	261.72
STRAIN B. =	-2220.09	97.84	161.72
STRAIN C. =	-1745.15	-2.16	151.72
LONG. STRN. =	-2220.09	97.84	251.72
PRINC. STRN. =	-2242.49	197.84	277.79
140.00			
TEMPERATURE	274.45	227.70	195.27
STRAIN A. (MECH.)	-1598.87	198.68	247.46
STRAIN B. =	-2189.90	98.68	177.46
STRAIN C. =	-1736.07	-1.32	137.46
LONG. STRN. =	-2189.90	98.68	207.46
PRINC. STRN. =	-2229.63	198.68	249.47
150.00			
TEMPERATURE	270.63	227.70	198.13
STRAIN A. (MECH.)	-1620.62	218.68	260.97
STRAIN B. =	-2201.10	98.69	190.97
STRAIN C. =	-1757.82	-1.32	140.97
LONG. STRN. =	-2201.10	118.68	210.97
PRINC. STRN. =	-2239.97	219.13	261.80
520.00			
TEMPERATURE	205.76	194.31	191.45
STRAIN A. (MECH.)	-1751.63	256.30	252.86
STRAIN B. =	-1846.61	66.30	202.86
STRAIN C. =	-1751.62	46.30	102.86

LONG. STRN. =	-1846.61	236.3?	152.86
PRINC. STRN. =	-1866.29	286.4?	296.92
880.00			
TEMPERATURE	181.91	176.19	177.14
STRAIN A. (MECH.)	-1721.62	255.35	276.40
STRAIN B. =	-1721.62	55.35	186.40
STRAIN C. =	-1700.51	55.35	106.40
LONG. STRN. =	-1721.62	255.35	196.40
PRINC. STRN. =	-1742.72	296.77	276.55
1180.00			
TEMPERATURE	173.32	169.51	170.46
STRAIN A. (MECH.)	-1729.57	268.14	279.15
STRAIN B. =	-1697.86	48.14	179.15
STRAIN C. =	-1708.41	68.14	109.15
LONG. STRN. =	-1697.86	288.14	209.15
PRINC. STRN. =	-1730.38	324.35	280.47

PASS= 6

0.00			
TEMPERATURE	168.55	164.74	166.65
STRAIN A. (MECH.)	-1324.68	313.17	335.14
STRAIN B. =	-1725.73	273.17	335.14
STRAIN C. =	-1472.43	163.17	165.14
LONG. STRN. =	-1725.73	293.17	165.14
PRINC. STRN. =	-1732.56	320.93	370.35
1.00			
TEMPERATURE	168.55	164.74	166.65
STRAIN A. (MECH.)	-1324.68	313.17	335.14
STRAIN B. =	-1725.73	273.17	335.14
STRAIN C. =	-1472.43	163.17	155.14
LONG. STRN. =	-1725.73	293.17	155.14
PRINC. STRN. =	-1732.56	320.93	372.42
3.00			
TEMPERATURE	168.55	164.74	166.65
STRAIN A. (MECH.)	-1324.68	323.17	355.14
STRAIN B. =	-1736.29	283.17	345.14
STRAIN C. =	-1472.43	153.17	155.14
LONG. STRN. =	-1736.29	193.17	165.14
PRINC. STRN. =	-1744.32	334.35	389.68
8.00			
TEMPERATURE	168.55	164.74	166.65
STRAIN A. (MECH.)	-1303.57	343.17	385.14
STRAIN C. =	-379.79	-116.83	-14.86
LONG. STRN. =	-527.54	353.17	285.14
PRINC. STRN. =	-1494.56	627.97	526.80

STRAIN B. =	-1789.06	303.17	395.14
STRAIN C. =	-1472.43	123.17	125.14
LONG. STRN. =	-1789.06	163.17	155.14
PRINC. STRN. =	-1800.05	363.55	419.15
14.00			
TEMPERATURE	168.55	164.74	166.65
STRAIN A. (MECH.)	-1271.91	433.17	465.14
STRAIN B. =	-1957.92	313.17	345.14
STRAIN C. =	-1451.32	-6.83	35.14
LONG. STRN. =	-1957.92	113.17	155.14
PRINC. STRN. =	-1994.93	454.83	485.19
16.00			
TEMPERATURE	168.55	164.74	166.65
STRAIN A. (MECH.)	-1261.35	513.17	495.14
STRAIN B. =	-2105.68	283.17	315.14
STRAIN C. =	-1293.01	-86.83	-4.86
LONG. STRN. =	-2105.68	143.17	175.14
PRINC. STRN. =	-2258.59	521.23	504.76
18.00			
TEMPERATURE	168.55	164.74	166.65
STRAIN A. (MECH.)	-1356.34	633.17	525.14
STRAIN B. =	-2126.79	233.17	275.14
STRAIN C. =	-1050.27	-146.83	-34.86
LONG. STRN. =	-2126.79	223.17	215.14
PRINC. STRN. =	-2532.94	603.20	526.74
19.00			
TEMPERATURE	169.51	164.74	166.65
STRAIN A. (MECH.)	-1593.51	623.17	535.14
STRAIN B. =	-1846.61	233.17	255.14
STRAIN C. =	-970.82	-166.83	-34.86
LONG. STRN. =	-1846.61	253.17	245.14
PRINC. STRN. =	-2480.12	623.96	535.18
20.00 (ARC)			
TEMPERATURE	169.51	164.74	166.65
STRAIN A. (MECH.)	-1730.71	623.17	535.14
STRAIN B. =	-1361.32	173.17	245.14
STRAIN C. =	-844.17	-156.83	-24.86
LONG. STRN. =	-1361.32	293.17	265.14
PRINC. STRN. =	-2271.75	627.76	535.32
21.00			
TEMPERATURE	169.51	164.74	166.65
STRAIN A. (MECH.)	-1234.67	613.17	525.14
STRAIN B. =	-527.54	143.17	225.14
LONG. STRN. =	282.94	425.14	395.14
PRINC. STRN. =	1406.61	445.91	429.68

22.00			
TEMPERATURE	181.91	165.69	166.65
STRAIN A. (MECH.)	-750.64	584.15	525.14
STRAIN B. "	167.56	124.15	215.14
STRAIN C. "	19.81	-65.85	5.14
LONG. STRN. "	167.56	394.15	315.14
PRINC. STRN. "	-846.26	611.37	529.90

24.00			
TEMPERATURE	205.76	165.69	166.65
STRAIN A. (MECH.)	644.15	504.15	495.14
STRAIN B. "	1002.99	104.15	185.14
STRAIN C. "	1002.99	34.15	45.14
LONG. STRN. "	1002.99	434.15	355.14
PRINC. STRN. "	1077.31	556.29	510.66

25.00			
TEMPERATURE	221.98	165.69	166.65
STRAIN A. (MECH.)	1149.81	484.15	475.14
STRAIN B. "	928.17	114.15	175.14
STRAIN C. "	1170.92	104.15	75.14
LONG. STRN. "	928.17	474.15	375.14
PRINC. STRN. "	1211.28	555.88	498.75

27.00			
TEMPERATURE	251.55	165.69	166.65
STRAIN A. (MECH.)	1573.61	454.15	445.14
STRAIN B. "	782.05	154.15	175.14
STRAIN C. "	1468.07	164.15	125.14
LONG. STRN. "	782.05	464.15	395.14
PRINC. STRN. "	1668.62	521.40	479.30

29.00			
TEMPERATURE	277.31	165.69	166.65
STRAIN A. (MECH.)	1594.20	414.15	415.14
STRAIN B. "	570.45	164.15	175.14
STRAIN C. "	1277.58	194.15	155.14
LONG. STRN. "	570.45	444.15	395.14
PRINC. STRN. "	1630.18	482.20	455.43

31.00			
TEMPERATURE	297.34	166.65	166.65
STRAIN A. (MECH.)	1391.13	375.14	385.14
STRAIN B. "	782.94	175.14	195.14
STRAIN C. "	968.96	225.14	205.14

34.00			
TEMPERATURE	320.24	170.46	167.60
STRAIN A. (MECH.)	1141.08	309.15	356.13
STRAIN B. "	-220.40	179.15	206.14
STRAIN C. "	550.06	239.15	236.14
LONG. STRN. "	-220.40	369.15	386.14
PRINC. STRN. "	1146.97	375.40	404.30

38.00			
TEMPERATURE	338.37	175.23	167.60
STRAIN A. (MECH.)	884.83	264.30	336.14
STRAIN B. "	-729.95	204.30	226.14
STRAIN C. "	188.27	244.30	256.14
LONG. STRN. "	-729.95	304.30	366.13
PRINC. STRN. "	892.40	305.29	376.76

41.00			
TEMPERATURE	346.00	180.96	167.60
STRAIN A. (MECH.)	685.18	240.66	336.14
STRAIN B. "	-1087.91	240.66	246.14
STRAIN C. "	-21.95	240.67	276.14
LONG. STRN. "	-1087.91	240.67	366.14
PRINC. STRN. "	-1115.89	240.67	373.22

45.00			
TEMPERATURE	350.77	187.63	167.60
STRAIN A. (MECH.)	406.00	228.35	336.14
STRAIN B. "	-1440.96	268.35	256.14
STRAIN C. "	-290.56	228.35	276.14
LONG. STRN. "	-1440.96	188.35	356.14
PRINC. STRN. "	-1468.43	268.35	364.44

50.00			
TEMPERATURE	351.72	196.22	168.55
STRAIN A. (MECH.)	94.75	198.63	327.14
STRAIN B. "	-1752.21	288.63	257.14
STRAIN C. "	-559.60	238.63	277.14
LONG. STRN. "	-1752.21	118.63	347.14
PRINC. STRN. "	-1790.63	288.77	353.61

55.00			
TEMPERATURE	349.81	203.85	171.42
STRAIN A. (MECH.)	-211.51	198.14	320.17
STRAIN B. "	-1952.93	318.14	270.17
STRAIN C. "	-908.07	208.14	270.17
LONG. STRN. "	-1952.93	88.14	320.17

PRINC. STRN. =	-1970.18	318.25	330.53

60.00

TEMPERATURE	346.95	211.48	174.28
STRAIN A. (MECH.)	-592.06	207.99	323.26
STRAIN B. =	-2222.38	337.99	273.26
STRAIN C. =	-1771.97	177.99	273.26
LONG. STRN. =	-2222.38	47.99	323.26
PRINC. STRN. =	-2273.03	338.77	333.61

70.00

TEMPERATURE	334.55	221.98	180.50
STRAIN A. (MECH.)	-740.96	192.10	329.59
STRAIN B. =	-2334.63	352.09	279.59
STRAIN C. =	-1268.67	152.10	249.59
LONG. STRN. =	-2334.63	-7.90	299.59
PRINC. STRN. =	-2378.85	353.20	330.82

80.00

TEMPERATURE	325.01	230.56	186.68
STRAIN A. (MECH.)	-963.82	201.17	307.23
STRAIN B. =	-2451.94	361.17	297.23
STRAIN C. =	-1491.57	131.17	227.23
LONG. STRN. =	-2451.94	-28.83	237.23
PRINC. STRN. =	-2482.76	364.29	317.23

95.00

TEMPERATURE	310.70	236.29	192.40
STRAIN A. (MECH.)	-1150.52	195.97	284.00
STRAIN B. =	-2575.30	375.97	314.00
STRAIN C. =	-1572.66	115.97	204.00
LONG. STRN. =	-2575.30	-64.03	174.00
PRINC. STRN. =	-2632.15	379.58	324.62

110.00

TEMPERATURE	296.39	238.20	200.04
STRAIN A. (MECH.)	-1210.56	207.51	283.34
STRAIN B. =	-2487.61	397.51	333.34
STRAIN C. =	-1632.73	117.51	193.34
LONG. STRN. =	-2487.61	-72.49	143.34
PRINC. STRN. =	-2573.27	401.78	343.46

125.00

TEMPERATURE	285.90	238.20	204.81
STRAIN A. (MECH.)	-1312.17	227.51	289.35
STRAIN B. =	-2462.57	397.51	359.35
STRAIN C. =	-1692.12	117.51	189.35
LONG. STRN. =	-2462.57	-52.49	119.35
PRINC. STRN. =	-2494.81	404.14	369.35

136.00

TEMPERATURE	277.31	237.24	206.71
STRAIN A. (MECH.)	-1276.51	246.74	291.79
STRAIN B. =	-2405.80	396.74	361.79
STRAIN C. =	-1635.35	116.75	191.79
LONG. STRN. =	-2405.80	-33.25	121.79
PRINC. STRN. =	-2442.14	406.35	371.79

208.00

TEMPERATURE	247.74	228.66	212.44
STRAIN A. (MECH.)	-1414.00	269.52	289.25
STRAIN B. =	-2290.00	389.52	389.25
STRAIN C. =	-1783.40	129.52	159.25
LONG. STRN. =	-2290.00	9.52	59.25
PRINC. STRN. =	-2295.34	402.00	401.59

358.00

TEMPERATURE	217.21	207.67	204.81
STRAIN A. (MECH.)	-1347.47	293.02	309.35
STRAIN B. =	-2033.49	363.02	399.35
STRAIN C. =	-1653.54	163.02	159.35
LONG. STRN. =	-2033.49	93.02	69.35
PRINC. STRN. =	-2035.47	377.85	415.60

1380.00

TEMPERATURE	171.42	168.55	170.46
STRAIN A. (MECH.)	-1202.41	337.14	369.15
STRAIN B. =	-1751.22	377.14	399.15
STRAIN C. =	-1466.26	227.14	199.15
LONG. STRN. =	-1751.22	187.14	169.15
PRINC. STRN. =	-1751.43	391.91	427.16

PASS= 11

0.00

TEMPERATURE	170.46	166.65	169.51
STRAIN A. (MECH.)	-849.15	385.14	378.14
STRAIN B. =	-1820.12	575.14	518.14
STRAIN C. =	-1376.85	295.14	228.14
LONG. STRN. =	-1820.12	105.14	88.14
PRINC. STRN. =	-1821.95	579.41	530.85

1.00

TEMPERATURE	170.46	166.65	169.51
STRAIN A. (MECH.)	-849.15	385.14	378.14
STRAIN B. =	-1830.68	575.14	518.14
STRAIN C. =	-1376.85	295.14	218.14

LONG. STRN. "	-1830.68	105.14	78.14
PRINC. STRN. "	-1832.07	579.41	532.24
5.00			
TEMPERATURE	170.46	166.65	169.51
STRAIN A. (MECH.)	-817.49	415.14	398.14
STRAIN B. "	-1872.89	605.14	528.14
STRAIN C. "	-1355.74	275.14	198.14
LONG. STRN. "	-1872.89	85.14	68.14
PRINC. STRN. "	-1873.00	614.40	548.94
10.00			
TEMPERATURE	170.46	166.65	169.51
STRAIN A. (MECH.)	-743.61	485.14	468.14
STRAIN B. "	-2010.10	645.14	548.14
STRAIN C. "	-1302.97	185.14	128.14
LONG. STRN. "	-2010.10	25.14	48.14
PRINC. STRN. "	-2014.39	679.52	600.47
14.00			
TEMPERATURE	170.46	166.65	169.51
STRAIN A. (MECH.)	-595.85	655.14	558.14
STRAIN B. "	-2263.39	645.14	508.14
STRAIN C. "	-1049.67	15.14	28.14
LONG. STRN. "	-2263.39	25.14	78.14
PRINC. STRN. "	-2345.88	780.67	634.39
16.00			
TEMPERATURE	171.42	166.65	169.51
STRAIN A. (MECH.)	-558.61	765.14	598.14
STRAIN B. "	-2426.68	575.14	458.14
STRAIN C. "	-653.60	-114.86	-21.86
LONG. STRN. "	-2426.68	75.14	118.14
PRINC. STRN. "	-2748.21	831.20	641.70
17.00			
TEMPERATURE	171.42	166.65	169.51
STRAIN A. (MECH.)	-674.71	805.14	608.14
STRAIN B. "	-2310.59	505.14	418.14
STRAIN C. "	-326.42	-184.86	-41.86
LONG. STRN. "	-2310.59	115.14	148.14
PRINC. STRN. "	-2917.12	842.17	635.06
18.00			
TEMPERATURE	174.28	166.65	169.51
STRAIN A. (MECH.)	-1090.71	825.14	618.14
STRAIN B. "	-1797.83	425.14	388.14
STRAIN C. "	-161.95	-234.86	-51.86
LONG. STRN. "	-1797.83	165.14	178.14

PRINC. STRN. "	-2774.44	840.85	634.21
19.00			
TEMPERATURE	179.05	166.65	169.51
STRAIN A. (MECH.)	-915.10	805.14	608.14
STRAIN B. "	-482.38	335.14	358.14
STRAIN C. "	119.20	-224.86	-51.86
LONG. STRN. "	-482.38	245.14	198.14
PRINC. STRN. "	-1544.81	807.10	617.70
20.00 (ARC)			
TEMPERATURE	190.50	166.65	169.51
STRAIN A. (MECH.)	-35.68	755.14	598.14
STRAIN B. "	935.29	245.14	328.14
STRAIN C. "	924.74	-184.86	-41.86
LONG. STRN. "	935.29	325.14	228.14
PRINC. STRN. "	1128.97	756.84	602.02
22.00			
TEMPERATURE	228.66	166.65	169.51
STRAIN A. (MECH.)	1895.55	605.14	538.14
STRAIN B. "	2106.63	145.14	258.14
STRAIN C. "	1695.03	-74.86	-21.86
LONG. STRN. "	2106.63	385.14	258.14
PRINC. STRN. "	2324.84	625.70	538.14
24.00			
TEMPERATURE	265.86	166.65	169.51
STRAIN A. (MECH.)	2510.46	495.14	488.14
STRAIN B. "	1761.11	125.14	218.14
STRAIN C. "	1761.12	65.14	48.14
LONG. STRN. "	1761.11	435.14	318.14
PRINC. STRN. "	2665.65	545.19	493.75
26.00			
TEMPERATURE	293.53	167.60	169.51
STRAIN A. (MECH.)	2541.08	426.14	438.14
STRAIN B. "	1116.27	166.14	218.14
STRAIN C. "	1517.33	166.14	108.14
LONG. STRN. "	1116.27	426.14	328.14
PRINC. STRN. "	2606.14	479.98	447.07
28.00			
TEMPERATURE	313.56	168.55	169.51
STRAIN A. (MECH.)	2253.61	367.14	398.14
STRAIN B. "	533.29	187.14	218.14
STRAIN C. "	1145.43	207.14	158.14
LONG. STRN. "	533.29	387.14	338.14
PRINC. STRN. "	2288.65	415.20	412.31

30.00

TEMPERATURE	326.92	170.46	169.51
STRAIN A. (MECH.)	1991.58	339.15	368.14
STRAIN B. "	123.50	219.15	228.14
STRAIN C. "	946.72	259.16	198.14
LONG. STRN. "	123.50	379.15	338.14
PRINC. STRN. "	1998.13	388.60	384.38

34.00

TEMPERATURE	345.04	175.23	169.51
STRAIN A. (MECH.)	1587.43	264.30	338.14
STRAIN B. "	-597.26	304.30	268.14
STRAIN C. "	415.93	314.30	268.14
LONG. STRN. "	-597.26	274.30	338.14
PRINC. STRN. "	1590.30	318.45	352.64

37.00

TEMPERATURE	354.58	180.96	169.51
STRAIN A. (MECH.)	1303.59	249.66	308.14
STRAIN B. "	-1071.17	350.66	298.14
STRAIN C. "	68.68	320.66	298.14
LONG. STRN. "	-1071.17	210.66	308.14
PRINC. STRN. "	1304.45	361.29	310.21

40.00

TEMPERATURE	358.40	185.73	169.51
STRAIN A. (MECH.)	1050.58	226.12	308.14
STRAIN B. "	-1345.20	396.12	328.14
STRAIN C. "	-142.03	316.13	308.14
LONG. STRN. "	-1345.20	146.13	288.14
PRINC. STRN. "	-1345.21	403.98	328.14

45.00

TEMPERATURE	359.35	194.31	170.46
STRAIN A. (MECH.)	654.90	226.30	309.15
STRAIN B. "	-1719.77	476.30	359.15
STRAIN C. "	-495.49	306.30	319.15
LONG. STRN. "	-1719.77	56.30	269.15
PRINC. STRN. "	-1720.35	480.08	359.43

55.00

TEMPERATURE	354.58	210.53	174.28
STRAIN A. (MECH.)	-26.31	216.74	323.26
STRAIN B. "	-2232.12	526.74	383.26
STRAIN C. "	-1071.17	256.74	303.26
LONG. STRN. "	-2232.12	-53.26	243.26
PRINC. STRN. "	-2233.64	527.43	383.97

70.00

TEMPERATURE	337.41	228.66	183.82
STRAIN A. (MECH.)	-524.26	229.52	303.92
STRAIN B. "	-2518.98	569.52	403.92
STRAIN C. "	-1463.57	209.52	263.92
LONG. STRN. "	-2518.98	-130.48	163.92
PRINC. STRN. "	-2520.67	569.66	405.58

90.00

TEMPERATURE	314.52	239.15	195.27
STRAIN A. (MECH.)	-801.66	228.27	297.46
STRAIN B. "	-2543.08	598.27	437.46
STRAIN C. "	-1635.43	178.28	237.46
LONG. STRN. "	-2543.08	-191.73	97.46
PRINC. STRN. "	-2543.87	599.07	440.09

120.00

TEMPERATURE	288.76	241.06	205.76
STRAIN A. (MECH.)	-968.77	239.78	270.57
STRAIN B. "	-2499.11	609.78	480.57
STRAIN C. "	-1739.22	169.78	210.57
LONG. STRN. "	-2499.11	-200.22	0.57
PRINC. STRN. "	-2499.13	611.29	482.44

170.00

TEMPERATURE	261.09	235.33	213.39
STRAIN A. (MECH.)	-1041.88	265.19	270.51
STRAIN B. "	-2361.14	605.19	500.51
STRAIN C. "	-1706.79	185.19	190.51
LONG. STRN. "	-2361.14	-154.81	-39.49
PRINC. STRN. "	-2361.16	607.28	503.46

296.00

TEMPERATURE	225.79	215.30	208.62
STRAIN A. (MECH.)	-1044.47	303.05	284.26
STRAIN B. "	-2184.32	583.05	514.26
STRAIN C. "	-1994.34	233.05	194.26
LONG. STRN. "	-2184.32	-46.95	-35.74
PRINC. STRN. "	-2299.35	584.98	517.91

596.00

TEMPERATURE	200.04	194.31	194.31
STRAIN A. (MECH.)	-1003.89	316.30	306.30
STRAIN B. "	-2017.08	566.30	496.30
STRAIN C. "	-1563.26	256.30	196.30
LONG. STRN. "	-2017.08	6.30	6.30
PRINC. STRN. "	-2019.82	567.91	502.40

1620.00			
TEMPERATURE	169.51	166.65	168.55
STRAIN A. (MECH.)	-896.94	345.14	317.14
STRAIN B. "	-1846.81	575.14	497.14
STRAIN C. "	-1424.64	295.14	217.14
LONG. STRN. "	-1846.81	65.14	37.14
PRINC. STRN. "	-1849.73	576.36	502.51

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0.00			
TEMPERATURE	168.55	165.69	167.60
STRAIN A. (MECH.)	-839.19	384.15	366.13
STRAIN B. "	-1789.06	594.15	516.14
STRAIN C. "	-1335.23	304.15	226.14
LONG. STRN. "	-1789.06	94.15	76.14
PRINC. STRN. "	-1789.52	597.33	527.00

1.00			
TEMPERATURE	168.55	165.69	167.60
STRAIN A. (MECH.)	-818.08	404.15	386.14
STRAIN B. "	-1799.61	604.15	526.14
STRAIN C. "	-1324.68	294.15	236.14
LONG. STRN. "	-1799.61	94.15	96.14
PRINC. STRN. "	-1799.86	610.02	538.84

5.00			
TEMPERATURE	168.55	165.69	167.60
STRAIN A. (MECH.)	-796.97	434.15	406.13
STRAIN B. "	-1810.16	624.15	526.14
STRAIN C. "	-1303.57	284.15	206.14
LONG. STRN. "	-1810.16	94.15	86.14
PRINC. STRN. "	-1810.16	634.56	547.80

10.00			
TEMPERATURE	168.55	165.69	167.60
STRAIN A. (MECH.)	-733.65	504.15	466.14
STRAIN B. "	-1894.60	644.15	536.14
STRAIN C. "	-1208.58	214.15	156.14
LONG. STRN. "	-1894.60	74.15	86.14
PRINC. STRN. "	-1904.11	678.92	584.36

15.00			
TEMPERATURE	168.55	165.69	167.60
STRAIN A. (MECH.)	-712.54	624.15	516.14
STRAIN B. "	-1968.47	584.15	476.14
STRAIN C. "	-976.39	54.15	56.14
LONG. STRN. "	-1968.47	94.15	96.14
PRINC. STRN. "	-2066.42	714.98	584.46

17.00			
TEMPERATURE	168.55	165.69	167.60
STRAIN A. (MECH.)	-828.63	664.15	536.14
STRAIN B. "	-1884.04	514.15	436.14
STRAIN C. "	-870.85	-5.85	36.14
LONG. STRN. "	-1884.04	144.15	136.14
PRINC. STRN. "	-2073.39	711.84	577.68

20.00 (ARC)			
TEMPERATURE	169.51	165.69	167.60
STRAIN A. (MECH.)	-1245.22	644.15	526.13
STRAIN B. "	-1509.07	364.15	366.13
STRAIN C. "	-1002.48	-45.85	16.14
LONG. STRN. "	-1509.07	234.15	176.14
PRINC. STRN. "	-1774.37	650.22	543.26

21.00			
TEMPERATURE	169.51	165.69	167.60
STRAIN A. (MECH.)	-1319.10	614.15	516.14
STRAIN B. "	-1361.32	324.15	336.14
STRAIN C. "	-1108.02	-35.85	16.14
LONG. STRN. "	-1361.32	254.15	196.14
PRINC. STRN. "	-1573.36	616.03	525.75

22.00			
TEMPERATURE	171.42	165.69	167.60
STRAIN A. (MECH.)	-1381.83	574.15	496.14
STRAIN B. "	-1350.17	284.15	316.14
STRAIN C. "	-1223.52	-5.85	26.14
LONG. STRN. "	-1350.17	284.15	206.14
PRINC. STRN. "	-1509.36	574.15	502.49

24.00			
TEMPERATURE	173.32	165.69	167.60
STRAIN A. (MECH.)	-1212.37	504.15	466.14
STRAIN B. "	-1265.14	244.15	276.14
STRAIN C. "	-1244.04	54.15	56.14
LONG. STRN. "	-1265.14	314.15	246.14
PRINC. STRN. "	-1265.67	506.86	466.68

26.00			
TEMPERATURE	177.14	166.65	168.55
STRAIN A. (MECH.)	-1031.78	435.14	427.14
STRAIN B. "	-1221.75	235.14	267.14
STRAIN C. "	-1179.53	125.14	77.14
LONG. STRN. "	-1221.75	325.14	237.14
PRINC. STRN. "	-1235.43	441.54	427.78

29.00			
TEMPERATURE	185.73	166.65	168.55
STRAIN A. (MECH.)	-738.94	385.14	387.14
STRAIN B. "	-1171.66	255.14	257.14
STRAIN C. "	-1045.01	205.14	147.14
LONG. STRN. "	-1171.66	335.14	277.14
PRINC. STRN. "	-1189.52	393.63	387.55

34.00			
TEMPERATURE	202.90	167.60	168.55
STRAIN A. (MECH.)	-375.11	326.13	337.14
STRAIN B. "	-1156.12	326.13	297.14
STRAIN C. "	-892.27	316.14	217.14
LONG. STRN. "	-1156.12	316.14	257.14
PRINC. STRN. "	-1176.14	328.21	340.38

39.00			
TEMPERATURE	221.02	168.55	168.55
STRAIN A. (MECH.)	-269.96	317.14	317.14
STRAIN B. "	-1325.37	397.14	337.14
STRAIN C. "	-955.98	347.14	267.14
LONG. STRN. "	-1325.37	267.14	247.14
PRINC. STRN. "	-1348.61	398.84	343.61

45.00			
TEMPERATURE	235.33	171.42	169.51
STRAIN A. (MECH.)	-208.38	310.17	318.14
STRAIN B. "	-1464.31	450.17	378.14
STRAIN C. "	-978.82	360.17	298.14
LONG. STRN. "	-1464.31	220.17	238.14
PRINC. STRN. "	-1480.27	452.86	378.85

50.00			
TEMPERATURE	243.92	174.28	169.51
STRAIN A. (MECH.)	-243.34	323.26	328.14
STRAIN B. "	-1573.16	483.26	398.14
STRAIN C. "	-1034.99	363.26	298.14
LONG. STRN. "	-1573.16	203.26	228.14
PRINC. STRN. "	-1585.11	484.68	399.46

58.00			
TEMPERATURE	251.55	180.96	169.51
STRAIN A. (MECH.)	-326.12	330.66	358.14
STRAIN B. "	-1698.15	490.66	398.14
STRAIN C. "	-1117.68	340.67	288.14
LONG. STRN. "	-1698.15	180.67	248.14
PRINC. STRN. "	-1706.22	490.74	405.91

66.00			
TEMPERATURE	254.41	185.73	171.42
STRAIN A. (MECH.)	-394.13	326.12	350.17
STRAIN B. "	-1776.72	496.12	400.17
STRAIN C. "	-1175.14	306.13	260.17
LONG. STRN. "	-1776.72	136.13	210.17
PRINC. STRN. "	-1782.52	496.40	410.29

75.00			
TEMPERATURE	257.28	192.40	173.32
STRAIN A. (MECH.)	-536.04	304.00	332.22
STRAIN B. "	-1939.73	514.00	402.22
STRAIN C. "	-1317.04	284.00	252.23
LONG. STRN. "	-1939.73	74.00	182.22
PRINC. STRN. "	-1944.18	514.23	409.27

90.00			
TEMPERATURE	257.28	199.08	177.14
STRAIN A. (MECH.)	-694.35	302.15	336.40
STRAIN B. "	-2076.94	542.15	416.40
STRAIN C. "	-1464.80	262.15	236.40
LONG. STRN. "	-2076.94	22.15	156.40
PRINC. STRN. "	-2081.45	542.92	425.68

110.00			
TEMPERATURE	253.46	206.71	182.86
STRAIN A. (MECH.)	-800.67	291.79	312.83
STRAIN B. "	-2151.59	561.79	422.83
STRAIN C. "	-1561.56	241.79	222.83
LONG. STRN. "	-2151.59	-28.21	112.83
PRINC. STRN. "	-2156.85	562.85	429.23

140.00			
TEMPERATURE	246.78	211.48	189.54
STRAIN A. (MECH.)	-912.34	297.99	310.59
STRAIN B. "	-2211.05	577.99	450.59
STRAIN C. "	-1651.68	227.99	210.59
LONG. STRN. "	-2211.05	-52.01	70.59
PRINC. STRN. "	-2217.92	579.93	457.06

165.00			
TEMPERATURE	241.06	211.48	193.36
STRAIN A. (MECH.)	-977.49	297.99	395.15
STRAIN B. "	-2222.88	577.99	475.15
STRAIN C. "	-1695.17	227.99	195.15
LONG. STRN. "	-2222.88	-52.01	25.15
PRINC. STRN. "	-2230.08	579.93	481.78

297.00

TEMPERATURE	216.25	204.81	197.17
STRAIN A. (MECH.)	-930.84	309.35	309.80
STRAIN B. =	-2063.12	569.35	479.80
STRAIN C. =	-1585.19	239.35	179.80
LONG. STRN. =	-2063.12	-20.65	9.80
PRINC. STRN. =	-2067.21	571.42	488.62

597.00

TEMPERATURE	196.22	189.54	188.59
STRAIN A. (MECH.)	-899.44	330.59	319.47
STRAIN B. =	-1954.85	600.59	489.47
STRAIN C. =	-1511.58	250.59	189.47
LONG. STRN. =	-1954.85	-19.41	19.47
PRINC. STRN. =	-1961.56	603.16	498.29

897.00

TEMPERATURE	181.91	177.14	179.05
STRAIN A. (MECH.)	-887.04	326.40	318.52
STRAIN B. =	-1911.59	586.40	488.52
STRAIN C. =	-1489.42	286.40	188.52
LONG. STRN. =	-1911.59	26.40	18.52
PRINC. STRN. =	-1919.39	587.11	497.34

1497.00

TEMPERATURE	166.65	163.78	165.69
STRAIN A. (MECH.)	-859.34	312.19	304.15
STRAIN B. =	-1852.98	572.19	484.15
STRAIN C. =	-1430.82	272.19	174.15
LONG. STRN. =	-1852.98	12.19	-5.85
PRINC. STRN. =	-1859.19	572.91	492.63

2397.00

TEMPERATURE	154.24	151.38	154.24
STRAIN A. (MECH.)	-870.12	350.03	322.75
STRAIN B. =	-1809.44	610.03	502.75
STRAIN C. =	-1397.82	300.03	202.75
LONG. STRN. =	-1809.44	40.03	22.75
PRINC. STRN. =	-1813.01	611.12	510.13

PASS= 18

0.00

TEMPERATURE	173.32	169.51	171.42
STRAIN A. (MECH.)	-610.79	418.14	380.17
STRAIN B. =	-1919.50	818.14	660.17
STRAIN C. =	-1349.58	368.14	290.17
LONG. STRN. =	-1919.50	-31.86	-29.83
PRINC. STRN. =	-1924.92	818.88	666.24

1.00

TEMPERATURE	173.32	169.51	171.42
STRAIN A. (MECH.)	-600.24	428.14	390.17
STRAIN B. =	-1919.50	828.14	560.17
STRAIN C. =	-1339.02	368.14	250.17
LONG. STRN. =	-1919.50	-31.86	80.17
PRINC. STRN. =	-1924.23	829.19	570.17

5.00

TEMPERATURE	173.32	169.51	171.42
STRAIN A. (MECH.)	-558.02	458.14	460.17
STRAIN B. =	-1951.16	848.14	680.17
STRAIN C. =	-1317.91	348.14	230.17
LONG. STRN. =	-1951.16	-41.86	10.17
PRINC. STRN. =	-1954.03	851.53	699.36

10.00

TEMPERATURE	173.32	169.51	171.42
STRAIN A. (MECH.)	-463.03	528.14	470.17
STRAIN B. =	-2056.70	888.14	680.17
STRAIN C. =	-1233.48	278.14	170.17
LONG. STRN. =	-2056.70	-81.86	-39.83
PRINC. STRN. =	-2057.14	903.99	710.17

13.00

TEMPERATURE	173.32	169.51	171.42
STRAIN A. (MECH.)	-368.05	618.14	530.17
STRAIN B. =	-2172.79	898.14	660.17
STRAIN C. =	-1075.17	188.14	120.17
LONG. STRN. =	-2172.79	-91.86	-9.83
PRINC. STRN. =	-2193.68	942.82	717.92

15.00

TEMPERATURE	173.32	169.51	171.42
STRAIN A. (MECH.)	-283.61	718.14	570.17
STRAIN B. =	-2436.65	868.14	630.17
STRAIN C. =	-853.53	78.14	60.17
LONG. STRN. =	-2436.65	-71.86	0.17
PRINC. STRN. =	-2549.89	966.74	720.45

17.00

TEMPERATURE	174.28	173.46	172.37
STRAIN A. (MECH.)	-278.04	809.15	601.20
STRAIN B. =	-2146.12	799.15	591.20
STRAIN C. =	-468.02	-20.85	21.20
LONG. STRN. =	-2146.12	-10.85	31.20
PRINC. STRN. =	-2406.25	974.02	714.31

18.00			
TEMPERATURE	174.28	170.46	172.37
STRAIN A. (MECH.)	-436.35	829.15	601.20
STRAIN B. "	-1935.03	709.15	551.20
STRAIN C. "	-294.16	-80.85	1.20
LONG. STRN. "	-1935.03	39.15	51.20
PRINC. STRN. "	-2420.57	939.18	691.71
19.00			
TEMPERATURE	178.09	170.46	172.37
STRAIN A. (MECH.)	-804.57	829.15	601.20
STRAIN B. "	-1543.36	629.15	511.20
STRAIN C. "	-276.87	-110.85	-8.80
LONG. STRN. "	-1543.36	89.15	81.20
PRINC. STRN. "	-2144.14	901.19	669.36
20.00 (ARC)			
TEMPERATURE	182.86	170.46	172.37
STRAIN A. (MECH.)	-966.71	809.15	591.20
STRAIN B. "	-1030.03	539.15	481.20
STRAIN C. "	-280.69	-120.84	-18.80
LONG. STRN. "	-1030.03	149.16	91.20
PRINC. STRN. "	-1716.75	848.39	648.20
21.00			
TEMPERATURE	186.68	171.42	172.37
STRAIN A. (MECH.)	-701.71	760.17	581.19
STRAIN B. "	-458.97	560.17	441.20
STRAIN C. "	353.69	-109.83	-8.80
LONG. STRN. "	-458.97	90.17	131.20
PRINC. STRN. "	-1522.23	819.59	619.44
23.00			
TEMPERATURE	200.04	171.42	172.37
STRAIN A. (MECH.)	-1.25	640.17	541.20
STRAIN B. "	209.83	360.17	391.20
STRAIN C. "	283.71	-19.83	31.20
LONG. STRN. "	209.83	260.17	181.20
PRINC. STRN. "	312.45	643.94	561.97
25.00			
TEMPERATURE	218.16	171.42	172.37
STRAIN A. (MECH.)	505.01	510.17	481.19
STRAIN B. "	325.60	310.17	351.20
STRAIN C. "	473.36	110.17	81.20
LONG. STRN. "	325.60	310.17	211.20
PRINC. STRN. "	522.16	510.17	493.09
27.00			
TEMPERATURE	235.33	171.42	172.37
STRAIN A. (MECH.)	794.26	430.17	431.20
STRAIN B. "	256.00	320.17	341.20
STRAIN C. "	994.79	220.17	141.20
LONG. STRN. "	256.00	330.17	231.20
PRINC. STRN. "	1066.43	430.29	441.28
30.00			
TEMPERATURE	257.28	171.42	172.37
STRAIN A. (MECH.)	994.30	340.17	371.19
STRAIN B. "	-92.77	380.17	351.20
STRAIN C. "	359.50	330.17	211.20
LONG. STRN. "	-92.77	290.17	231.20
PRINC. STRN. "	1003.47	380.45	391.19
33.00			
TEMPERATURE	273.49	173.32	172.37
STRAIN A. (MECH.)	1065.87	312.22	331.19
STRAIN B. "	-475.02	462.22	391.20
STRAIN C. "	327.09	402.22	281.20
LONG. STRN. "	-475.02	252.23	221.20
PRINC. STRN. "	1066.52	471.46	394.80
37.00			
TEMPERATURE	286.85	175.23	172.37
STRAIN A. (MECH.)	1057.35	274.30	261.20
STRAIN B. "	-863.49	574.30	491.20
STRAIN C. "	118.04	444.30	331.20
LONG. STRN. "	-863.49	144.30	101.20
PRINC. STRN. "	1057.58	590.49	494.31
42.00			
TEMPERATURE	299.25	180.96	172.37
STRAIN A. (MECH.)	789.75	280.66	311.20
STRAIN B. "	-1352.72	660.66	491.20
STRAIN C. "	-170.67	460.67	371.20
LONG. STRN. "	-1352.72	80.67	191.20
PRINC. STRN. "	-1358.44	674.31	494.17
49.00			
TEMPERATURE	303.07	189.54	172.37
STRAIN A. (MECH.)	537.02	280.59	311.20
STRAIN B. "	-1658.23	720.59	531.20
STRAIN C. "	-338.97	420.59	361.20
LONG. STRN. "	-1658.23	-19.41	141.20
PRINC. STRN. "	-1680.38	727.16	532.79
55.00			
TEMPERATURE	304.98	195.27	173.32

STRAIN A. (MECH.)	252.35	287.46	322.22
STRAIN B. "	-1921.79	747.46	542.22
STRAIN C. "	-613.09	397.46	342.22
LONG. STRN. "	-1921.79	-62.54	122.22
PRINC. STRN. "	-1944.16	751.18	542.46
60.00			
TEMPERATURE	304.98	201.94	175.23
STRAIN A. (MECH.)	41.26	305.73	344.30
STRAIN B. "	-2101.22	765.73	544.30
STRAIN C. "	-855.83	375.73	334.30
LONG. STRN. "	-2101.22	-84.27	134.30
PRINC. STRN. "	-2119.28	767.17	544.36
70.00			
TEMPERATURE	301.16	210.53	179.05
STRAIN A. (MECH.)	-212.62	296.74	328.52
STRAIN B. "	-2217.90	776.74	548.52
STRAIN C. "	-1141.38	336.74	308.52
LONG. STRN. "	-2217.90	-143.26	88.52
PRINC. STRN. "	-2220.62	777.17	548.74
80.00			
TEMPERATURE	294.48	217.21	183.82
STRAIN A. (MECH.)	-355.91	295.61	313.92
STRAIN B. "	-2382.29	785.61	563.92
STRAIN C. "	-1263.56	315.61	293.92
LONG. STRN. "	-2382.29	-174.39	43.92
PRINC. STRN. "	-2387.77	785.71	564.12
95.00			
TEMPERATURE	284.94	222.93	190.50
STRAIN A. (MECH.)	-494.36	293.41	301.72
STRAIN B. "	-2436.31	803.41	571.72
STRAIN C. "	-1433.67	283.41	261.72
LONG. STRN. "	-2436.31	-226.59	-8.28
PRINC. STRN. "	-2436.83	803.43	572.41
110.00			
TEMPERATURE	279.22	225.79	194.31
STRAIN A. (MECH.)	-674.62	336.99	306.30
STRAIN B. "	-2563.81	816.99	586.30
STRAIN C. "	-1613.94	286.99	256.30
LONG. STRN. "	-2563.81	-223.01	-23.70
PRINC. STRN. "	-2563.82	817.98	587.33
130.00			
TEMPERATURE	265.86	226.75	200.04
STRAIN A. (MECH.)	-602.99	337.84	293.34

STRAIN B. "	-2418.33	817.84	613.34
STRAIN C. "	-1552.87	267.84	233.34
LONG. STRN. "	-2418.33	-242.16	-86.66
PRINC. STRN. "	-2419.78	818.21	614.62
150.00			
TEMPERATURE	257.28	225.79	202.90
STRAIN A. (MECH.)	-673.24	336.99	296.93
STRAIN B. "	-2393.55	816.99	616.93
STRAIN C. "	-1570.34	276.99	226.93
LONG. STRN. "	-2393.55	-233.01	-93.07
PRINC. STRN. "	-2394.35	817.20	618.65
168.00			
TEMPERATURE	250.60	223.89	204.81
STRAIN A. (MECH.)	-669.34	324.73	299.35
STRAIN B. "	-2357.98	814.73	639.35
STRAIN C. "	-1576.98	284.73	229.35
LONG. STRN. "	-2357.98	-205.27	-110.65
PRINC. STRN. "	-2360.36	815.12	640.98
297.00			
TEMPERATURE	220.07	208.62	200.99
STRAIN A. (MECH.)	-697.65	344.26	304.53
STRAIN B. "	-2185.77	804.26	644.53
STRAIN C. "	-1510.31	304.26	214.53
LONG. STRN. "	-2185.77	-155.74	-125.47
PRINC. STRN. "	-2188.93	804.67	647.15
537.00			
TEMPERATURE	196.22	188.59	188.59
STRAIN A. (MECH.)	-646.15	379.47	319.47
STRAIN B. "	-2049.84	799.47	649.47
STRAIN C. "	-1427.15	339.47	229.47
LONG. STRN. "	-2049.84	-80.53	-100.53
PRINC. STRN. "	-2054.29	799.92	652.16
897.00			
TEMPERATURE	177.14	172.37	174.28
STRAIN A. (MECH.)	-525.18	391.20	353.26
STRAIN B. "	-1907.77	821.19	663.26
STRAIN C. "	-1295.63	371.20	253.26
LONG. STRN. "	-1907.77	-58.80	-56.74
PRINC. STRN. "	-1912.28	821.31	666.71
1797.00			
TEMPERATURE	157.11	153.29	155.20
STRAIN A. (MECH.)	-505.09	381.83	343.66
STRAIN B. "	-1855.01	801.83	643.66
STRAIN C. "	-1264.98	361.84	243.67
LONG. STRN. "	-1856.01	-58.16	-56.34

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PRINC. STRN. =        -1861.26        801.95        647.22

 2037.00
TEMPERATURE             154.24        150.43        152.34
STRAIN A. (MECH.)      -532.39        389.13        350.93
STRAIN B.    =        -1883.31        809.13        650.93
STRAIN C.    =        -1228.96        369.14        250.93
LONG. STRN.  =        -1883.31        -50.86        -49.07
PRINC. STRN. =        -1883.64        809.25        654.48

 2157.00
TEMPERATURE             152.34        147.57        150.43
STRAIN A. (MECH.)      -480.23        385.81        359.14
STRAIN B.    =        -1841.71        805.81        649.14
STRAIN C.    =        -1102.92        375.81        249.14
LONG. STRN.  =        -1841.71        -44.19        -40.86
PRINC. STRN. =        -1844.18        805.84        653.49

 2700.00
TEMPERATURE             145.66        141.84        143.75
STRAIN A. (MECH.)      -477.13        359.37        331.45
STRAIN B.    =        -1828.05        779.37        621.45
STRAIN C.    =        -1110.37        349.37        241.45
LONG. STRN.  =        -1828.05        -70.63        -48.55
PRINC. STRN. =        -1829.37        779.40        624.46

10000.00
TEMPERATURE             119.90        117.99        119.90
STRAIN A. (MECH.)      -300.92        349.04        360.28
STRAIN B.    =         -786.41        789.04        640.28
STRAIN C.    =         -480.34        379.04        240.28
LONG. STRN.  =         -786.41        -60.96        -39.72
PRINC. STRN. =         -794.53        789.31        645.53

COMPILE TIME=     0.76 SEC,EXECUTION TIME=     8.87 SEC,OBJECT CODE=     8144 BYTES,ARRAY AREA=     7992 BYTES,UNUSED=    83864 BYTES

COMPILE TIME=     0.74 SEC,EXECUTION TIME=     0.00 SEC,OBJECT CODE=     8144 BYTES,ARRAY AREA=     7992 BYTES,UNUSED=    83864 BYTES
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WELDING STRAIN-TEMPERATURE VARIATION, EXPERIMENTAL RESULTS

METAL= HY-130 STEEL
THKSS(IN)=0.750
WELD PROCESS=GMA
WELD TYPE=BUTT WELD
NO PASSES= 8
CURRENT=DCRP
ARC VOLTAGE= 28.
AMPS= 290.
SPEED OF TRAVEL (IPM)= 14.0

WELD EDGE
H /|\
T A B C
THERMO-COUPLES STRAIN ROSETTES

TRANSVERSE DISTANCE FROM WELD.

TIME	1.0	1.75	2.5
PASS= 1			
0.00			
TEMPERATURE	72.20	72.20	72.20
STRAIN A (MECH.)	-0.00	-0.00	-0.00
STRAIN B. "	-0.00	-0.00	-0.00
STRAIN C "	-0.00	-0.00	-0.00
LONG. STRN. "	0.00	0.00	0.00
PRINC. STRN. "	0.00	0.00	0.00
1.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A (MECH.)	-43.26	-54.65	-35.03
STRAIN B. "	6.74	-24.65	-15.03
STRAIN C. "	-63.26	-24.65	4.97
LONG. STRN. "	-113.26	-54.65	-15.03
PRINC. STRN. "	-114.09	-60.86	-35.03
2.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	-43.26	-54.65	-35.03
STRAIN B "	6.74	-24.65	-15.03
STRAIN C "	-63.26	-24.65	4.97
LONG. STRN. "	-113.26	-54.65	-15.03

WELDING STRAIN-TEMPERATURE VARIATION, EXPERIMENTAL RESULTS

METAL= 180KSI STEEL
THKSS(IN)=1.000
WELD PROCESS=GMA
WELD TYPE=BUTT WELD
NO.PASSES= 20
CURRENT=DCRP
ARC VOLTAGE= 28.
AMPS= 290.
SPEED OF TRAVEL (IPM)= 14.0

WELD EDGE
H /|\
T A B C
THERMO-COUPLES STRAIN ROSETTES

TRANSVERSE DISTANCE FROM WELD.

TIME	1.0	1.75	2.5
PASS= 1			
0.00			
TEMPERATURE	72.20	72.20	72.20
STRAIN A. (MECH.)	-0.00	-0.00	-0.00
STRAIN B. "	-0.00	-0.00	-0.00
STRAIN C. "	-0.00	-0.00	-0.00
LONG. STRN. "	0.00	0.00	0.00
PRINC. STRN. "	0.00	0.00	0.00
1.00			
TEMPERATURE	104.64	98.91	93.19
STRAIN A. (MECH.)	-65.24	-57.87	-39.73
STRAIN B. "	-35.24	-27.87	-29.73
STRAIN C. "	14.76	32.13	40.27
LONG. STRN. "	-18.24	2.13	30.27
PRINC. STRN. "	-66.47	-60.30	50.27
2.00			
TEMPERATURE	104.64	98.91	93.19
STRAIN A. (MECH.)	-65.24	-67.87	-49.73
STRAIN B. "	-45.24	-37.87	-39.73
STRAIN C. "	24.76	42.13	50.27
LONG. STRN. "	4.76	12.13	40.27

PRINC. STRN. =	-114.09	-60.86	-35.03
7.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	-23.26	-34.65	-45.03
STRAIN B. =	-3.26	-44.65	-45.03
STRAIN C. =	-193.26	-54.65	4.97
LONG. STRN. =	-123.26	-44.65	4.97
PRINC. STRN. =	-135.37	-54.65	-55.39
10.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	-3.26	-24.65	-45.03
STRAIN B. =	-23.26	-74.65	-65.03
STRAIN C. =	-143.26	-64.65	24.97
LONG. STRN. =	-123.26	-14.65	44.97
PRINC. STRN. =	-159.29	-80.70	-75.23
14.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	16.74	-34.65	-65.03
STRAIN B. =	-93.26	-124.65	-75.03
STRAIN C. =	-203.26	-44.65	74.97
LONG. STRN. =	-93.26	45.35	84.97
PRINC. STRN. =	-203.26	-124.79	111.27
17.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	-3.26	-64.65	-85.03
STRAIN B. =	-123.26	-104.65	-45.03
STRAIN C. =	-153.26	25.35	124.97
LONG. STRN. =	-33.26	65.36	84.97
PRINC. STRN. =	-165.73	-115.82	143.46
18.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	-13.26	-64.65	-85.03
STRAIN B. =	-103.26	-74.65	-25.03
STRAIN C. =	-113.26	55.35	144.97
LONG. STRN. =	-23.26	65.35	84.97
PRINC. STRN. =	-127.29	-96.84	157.44
19.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	-13.26	-64.65	-85.03
STRAIN B. =	-43.76	-24.65	14.97
STRAIN C. =	-93.26	75.35	144.97
LONG. STRN. =	-63.26	95.35	44.97
PRINC. STRN. =	-94.49	81.51	145.94

PRINC. STRN. =	-71.72	-73.28	64.30
10.00			
TEMPERATURE	105.55	98.91	93.19
STRAIN A. (MECH.)	-54.73	-77.87	-79.73
STRAIN B. =	-94.73	-57.87	-89.73
STRAIN C. =	5.27	92.13	90.27
LONG. STRN. =	45.27	72.13	100.27
PRINC. STRN. =	-100.85	-119.87	132.74
15.00			
TEMPERATURE	105.55	98.91	93.19
STRAIN A. (MECH.)	-34.73	-87.87	-99.73
STRAIN B. =	-164.73	-147.87	-109.73
STRAIN C. =	-4.73	82.13	120.27
LONG. STRN. =	125.27	142.13	130.27
PRINC. STRN. =	-165.50	-170.94	173.06
17.00			
TEMPERATURE	105.59	98.91	93.19
STRAIN A. (MECH.)	-34.73	-57.87	-99.73
STRAIN B. =	-184.73	-147.87	-109.73
STRAIN C. =	15.27	122.13	150.27
LONG. STRN. =	165.27	172.13	160.27
PRINC. STRN. =	-186.51	206.30	209.25
19.00			
TEMPERATURE	105.59	98.91	93.19
STRAIN A. (MECH.)	-34.73	-57.87	-99.73
STRAIN B. =	-194.73	-147.87	-89.73
STRAIN C. =	45.27	142.13	170.27
LONG. STRN. =	205.27	192.13	160.27
PRINC. STRN. =	209.23	230.22	219.25
20.00 (ARC PASSES)			
TEMPERATURE	105.55	98.91	93.19
STRAIN A. (MECH.)	-44.73	-57.87	-99.73
STRAIN B. =	-194.73	-137.87	-89.73
STRAIN C. =	65.27	152.13	170.27
LONG. STRN. =	215.27	192.13	160.27
PRINC. STRN. =	222.52	234.14	219.25
22.00			
TEMPERATURE	105.55	98.91	93.19
STRAIN A. (MECH.)	-34.73	-97.87	-99.73
STRAIN B. =	-174.73	-97.87	-59.73
STRAIN C. =	85.27	182.13	180.27
LONG. STRN. =	225.27	182.13	140.27
PRINC. STRN. =	234.08	240.12	212.31

20.00 (ARC PASSES)			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	26.74	-54.65	-75.03
STRAIN B. "	16.74	15.35	44.97
STRAIN C. "	-103.26	85.35	144.97
LONG. STRN. "	-93.26	15.35	24.97
PRINC. STRN. "	-123.41	85.35	145.42

21.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	86.74	-14.65	-55.03
STRAIN B. "	76.74	75.35	84.97
STRAIN C. "	-143.26	75.35	154.97
LONG. STRN. "	-133.26	-14.65	14.97
PRINC. STRN. "	-183.99	93.99	160.65

22.00			
TEMPERATURE	111.31	103.68	95.10
STRAIN A. (MECH.)	176.74	25.35	-25.03
STRAIN B. "	96.74	115.35	104.97
STRAIN C. "	-213.26	65.35	144.97
LONG. STRN. "	-133.26	-24.64	14.97
PRINC. STRN. "	-244.65	118.15	156.14

24.00			
TEMPERATURE	112.27	103.68	95.10
STRAIN A. (MECH.)	296.98	135.35	44.97
STRAIN B. "	26.98	175.35	154.97
STRAIN C. "	-353.02	15.35	104.97
LONG. STRN. "	-83.02	-24.65	-5.03
PRINC. STRN. "	-357.64	191.97	160.41

26.00			
TEMPERATURE	117.04	103.68	95.10
STRAIN A. (MECH.)	318.41	235.35	114.97
STRAIN B. "	-91.58	175.35	184.97
STRAIN C. "	-421.58	-54.65	54.97
LONG. STRN. "	-11.59	5.35	-15.03
PRINC. STRN. "	-423.74	258.43	189.37

28.00			
TEMPERATURE	121.81	103.68	95.10
STRAIN A. (MECH.)	290.23	305.35	184.97
STRAIN B. "	-219.77	135.35	174.97
STRAIN C. "	-459.77	-94.65	14.97
LONG. STRN. "	40.23	75.35	24.97
PRINC. STRN. "	-481.94	307.59	213.33

24.00	ERROR		
TEMPERATURE	105.59	58.91	93.19
STRAIN A. (MECH.)	-14.73	-67.87	-89.73
STRAIN B. "	2845.27	-67.87	-39.73
STRAIN C. "	75.27	182.13	190.27
LONG. STRN. "	2784.73	192.13	140.27
PRINC. STRN. "	2845.63	233.91	216.70

26.00			
TEMPERATURE	105.59	58.91	93.19
STRAIN A. (MECH.)	15.27	-37.87	-59.73
STRAIN B. "	-154.73	-57.87	-29.73
STRAIN C. "	45.27	172.13	170.27
LONG. STRN. "	215.27	192.13	140.27
PRINC. STRN. "	215.88	230.38	198.27

30.00			
TEMPERATURE	107.50	58.91	93.19
STRAIN A. (MECH.)	66.36	42.13	0.27
STRAIN B. "	-223.64	-67.87	-19.73
STRAIN C. "	26.36	142.13	170.27
LONG. STRN. "	316.36	252.13	190.27
PRINC. STRN. "	317.10	259.76	220.36

35.00			
TEMPERATURE	111.31	58.91	93.19
STRAIN A. (MECH.)	18.78	62.13	50.27
STRAIN B. "	-311.22	-117.87	-59.73
STRAIN C. "	58.78	62.13	120.27
LONG. STRN. "	388.78	242.13	230.27
PRINC. STRN. "	389.35	242.13	234.43

40.00			
TEMPERATURE	121.81	59.87	94.14
STRAIN A. (MECH.)	-82.84	42.92	60.53
STRAIN B. "	-332.83	-177.48	-99.47
STRAIN C. "	97.17	132.92	110.53
LONG. STRN. "	347.16	352.92	270.53
PRINC. STRN. "	358.87	356.31	272.21

45.00			
TEMPERATURE	133.26	100.82	94.14
STRAIN A. (MECH.)	-150.83	12.92	60.53
STRAIN B. "	-300.83	-197.08	-119.47
STRAIN C. "	109.17	142.92	110.53
LONG. STRN. "	259.17	352.92	290.53
PRINC. STRN. "	-325.34	360.50	292.05

30.00			
TEMPERATURE	138.98	103.68	95.10
STRAIN A. (MECH.)	209.93	355.35	244.97
STRAIN B. "	-290.07	95.35	154.97
STRAIN C. "	-470.07	-134.65	-25.03
LONG. STRN "	29.93	125.35	64.97
PRINC. STRN. "	-505.84	355.81	252.27

33.00			
TEMPERATURE	159.97	104.64	95.10
STRAIN A. (MECH.)	104.98	355.47	294.97
STRAIN B. "	-335.02	5.47	104.97
STRAIN C. "	-475.02	-144.53	-55.03
LONG. STRN "	-35.02	205.47	134.97
PRINC. STRN. "	-511.52	374.73	295.61

36.00			
TEMPERATURE	179.05	107.50	97.20
STRAIN A. (MECH.)	-1.72	325.92	304.95
STRAIN B. "	-341.72	-64.08	44.95
STRAIN C. "	-461.72	-134.08	-55.05
LONG. STRN. "	-121.72	255.92	204.94
PRINC. STRN. "	-486.67	376.10	321.92

40.00			
TEMPERATURE	202.90	111.31	97.96
STRAIN A. (MECH.)	-92.57	236.74	294.96
STRAIN B. "	-302.57	-123.26	-15.04
STRAIN C. "	-442.57	-83.26	-35.04
LONG STRN "	-232.57	276.74	274.96
PRINC. STRN. "	-446.04	332.86	349.62

45.00			
TEMPERATURE	223.89	118.95	100.82
STRAIN A. (MECH.)	-163.43	139.10	235.09
STRAIN B. "	-193.43	-120.90	-44.91
STRAIN C. "	-443.43	-40.90	5.09
LONG. STRN. "	-413.43	219.10	285.09
PRINC. STRN. "	-491.48	241.45	321.21

50.00			
TEMPERATURE	239.15	127.53	102.73
STRAIN A. (MECH.)	-186.42	52.92	185.25
STRAIN B. "	-116.42	-97.08	-44.75
STRAIN C. "	-496.42	-27.08	45.25
LONG. STRN "	-366.42	122.92	275.25
PRINC. STRN. "	-614.64	129.96	289.89

50.00			
TEMPERATURE	143.75	102.73	94.14
STRAIN A. (MECH.)	-157.23	3.80	50.53
STRAIN B. "	-247.23	-196.20	-129.47
STRAIN C. "	62.77	123.90	110.53
LONG. STRN. "	152.77	323.80	290.53
PRINC. STRN. "	-275.48	330.63	292.66

60.00			
TEMPERATURE	163.78	109.45	95.10
STRAIN A. (MECH.)	-139.59	16.93	90.81
STRAIN B. "	-209.59	-193.07	-139.20
STRAIN C. "	-5.59	66.93	90.81
LONG. STRN. "	60.41	276.93	320.81
PRINC. STRN. "	-224.43	278.26	320.81

70.00			
TEMPERATURE	177.14	116.08	97.96
STRAIN A. (MECH.)	-179.94	-17.72	61.77
STRAIN B. "	-179.94	-197.72	-138.23
STRAIN C. "	20.06	92.28	91.77
LONG. STRN. "	20.06	272.28	291.77
PRINC. STRN. "	-221.36	279.63	292.29

80.00			
TEMPERATURE	186.68	123.72	99.87
STRAIN A. (MECH.)	-204.81	-41.04	52.52
STRAIN B. "	-154.81	-191.04	-137.48
STRAIN C. "	5.19	88.96	92.52
LONG. STRN. "	-34.81	238.96	282.52
PRINC. STRN. "	-223.30	249.57	283.47

100.00			
TEMPERATURE	196.22	138.03	106.54
STRAIN A. (MECH.)	-219.79	-74.95	25.80
STRAIN B. "	-138.79	-184.95	-144.20
STRAIN C. "	21.21	75.05	95.80
LONG. STRN. "	-58.79	185.05	265.80
PRINC. STRN. "	-225.28	199.67	268.77

120.00			
TEMPERATURE	198.13	146.61	113.22
STRAIN A. (MECH.)	-215.48	-93.09	20.12
STRAIN B. "	-115.48	-163.09	-139.88
STRAIN C. "	34.52	66.91	90.12
LONG. STRN. "	-65.48	136.91	250.12
PRINC. STRN. "	-217.96	-183.09	253.23

60.00			
TEMPERATURE	250.23	143.79	109.41
STRAIN A. (MECH.)	-711.05	-56.50	126.90
STRAIN B. "	-21.09	-26.90	-23.70
STRAIN C. "	-561.05	-56.90	46.90
LONG. STRN. "	-791.09	-86.50	196.90
PRINC. STRN. "	-790.84	-86.90	203.95
70.00			
TEMPERATURE	260.82	159.01	117.99
STRAIN A. (MECH.)	-229.63	-125.64	78.75
STRAIN B. "	30.97	14.36	-1.25
STRAIN C. "	-579.63	-95.64	38.75
LONG. STRN. "	-819.63	-235.64	118.75
PRINC. STRN. "	-858.15	-236.54	121.99
85.00			
TEMPERATURE	268.72	176.19	130.39
STRAIN A. (MECH.)	-189.40	-163.83	44.46
STRAIN B. "	50.60	36.17	14.46
STRAIN C. "	-589.40	-143.83	-5.54
LONG. STRN. "	-829.40	-343.83	24.46
PRINC. STRN. "	-872.72	-344.09	44.96
100.00			
TEMPERATURE	264.91	187.63	140.89
STRAIN A. (MECH.)	-169.89	-165.15	21.31
STRAIN B. "	50.11	54.85	31.31
STRAIN C. "	-519.89	-155.15	-18.69
LONG. STRN "	-739.89	-375.15	-28.69
PRINC. STRN. "	-776.92	-375.20	37.36
125.00			
TEMPERATURE	256.32	196.22	154.24
STRAIN A. (MECH.)	-131.46	-168.21	-8.66
STRAIN B. "	68.55	61.79	61.34
STRAIN C. "	-471.45	-168.21	-48.66
LONG. STRN "	-671.45	-398.21	-118.66
PRINC. STRN. "	-708.64	-398.21	-120.86
150.00			
TEMPERATURE	247.74	209.04	163.78
STRAIN A. (MECH.)	-113.63	-155.02	-22.51
STRAIN B. "	86.37	84.98	67.49
STRAIN C. "	-423.63	-185.02	-72.51
LONG. STRN "	-673.63	-425.01	-162.51
PRINC. STRN. "	-655.99	-425.46	-165.19

200.00

150.00			
TEMPERATURE	197.17	155.20	122.76
STRAIN A. (MECH.)	-197.14	-101.27	-1.95
STRAIN B. "	-117.14	-151.27	-191.95
STRAIN C. "	32.86	38.73	78.05
LONG. STRN. "	-47.14	88.73	228.05
PRINC. STRN. "	-202.35	-170.19	232.22
200.00			
TEMPERATURE	191.45	159.97	132.30
STRAIN A. (MECH.)	-186.91	-114.88	-31.94
STRAIN B. "	-126.91	-144.88	-141.94
STRAIN C. "	33.09	25.12	48.06
LONG. STRN. "	-26.91	55.12	158.06
PRINC. STRN. "	-197.74	-166.94	163.30
328.00			
TEMPERATURE	175.23	159.01	141.84
STRAIN A. (MECH.)	-132.86	-116.17	-49.89
STRAIN B. "	-152.86	-146.17	-129.89
STRAIN C. "	57.14	33.83	20.11
LONG. STRN. "	77.14	63.83	100.11
PRINC. STRN. "	-187.02	-170.21	-135.09
548.00			
TEMPERATURE	151.38	144.70	137.07
STRAIN A. (MECH.)	-106.21	-95.87	-46.17
STRAIN B. "	-186.21	-155.87	-126.17
STRAIN C. "	73.79	34.13	13.83
LONG. STRN. "	153.79	94.13	93.83
PRINC. STRN. "	-208.56	-171.76	-130.19
528.00			
TEMPERATURE	131.35	127.53	125.62
STRAIN A. (MECH.)	-83.04	-77.20	-39.16
STRAIN B. "	-183.04	-157.20	-119.16
STRAIN C. "	106.96	52.80	20.84
LONG. STRN. "	206.96	132.80	100.84
PRINC. STRN. "	228.87	-171.11	-123.18
1080.00			
TEMPERATURE	127.53	123.72	121.81
STRAIN A. (MECH.)	-77.20	-61.04	-32.83
STRAIN B. "	-177.20	-141.04	-122.84
STRAIN C. "	112.80	88.56	27.17
LONG. STRN. "	212.80	139.56	117.17
PRINC. STRN. "	234.11	-153.36	-126.53

PASS= 2

TEMPERATURE	209.58	190.90	175.23
STRAIN A. (MECH.)	3.29	-62.88	-14.52
STRAIN B. "	33.29	77.12	75.48
STRAIN C. "	-296.71	-192.88	-124.52
LONG. STRN. "	-326.71	-332.87	-214.52
PRINC. STRN. "	-301.02	-342.93	-224.60

600.00

TEMPERATURE	173.32	165.69	159.97
STRAIN A. (MECH.)	94.10	28.70	44.98
STRAIN B. "	-5.90	28.70	64.98
STRAIN C. "	-165.90	-131.22	-115.02
LONG. STRN. "	-65.90	-131.22	-135.02
PRINC. STRN. "	-169.32	-164.36	-163.09

900.00

TEMPERATURE	149.47	147.57	144.70
STRAIN A. (MECH.)	130.28	76.62	74.26
STRAIN B. "	-21.72	16.62	44.26
STRAIN C. "	-141.72	-103.38	-95.74
LONG. STRN. "	18.28	-43.38	-65.74
PRINC. STRN. "	-143.14	-108.24	-111.99

1080.00

TEMPERATURE	139.93	138.98	138.03
STRAIN A. (MECH.)	160.61	109.93	89.26
STRAIN B. "	-29.39	9.93	49.26
STRAIN C. "	-99.39	-80.07	-80.74
LONG. STRN. "	90.61	19.93	-40.74
PRINC. STRN. "	173.79	110.06	100.44

PASS= 2

0.00

TEMPERATURE	138.98	138.03	137.07
STRAIN A. (MECH.)	89.93	49.26	68.61
STRAIN B. "	-40.07	-10.74	28.61
STRAIN C. "	-150.07	-130.74	-111.39
LONG. STRN. "	-20.07	-70.74	-71.39
PRINC. STRN. "	-150.49	-135.61	-124.35

1.00

TEMPERATURE	138.98	138.03	137.07
STRAIN A. (MECH.)	89.93	49.26	68.61
STRAIN B. "	-40.07	-10.74	18.61
STRAIN C. "	-150.07	-140.74	-121.39
LONG. STRN. "	-20.07	-80.74	-71.39
PRINC. STRN. "	-150.49	-146.98	-131.51

0.00

TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-79.16	-81.95	-43.70
STRAIN B. "	-209.16	-171.95	-123.70
STRAIN C. "	120.84	98.05	56.30
LONG. STRN. "	250.84	178.05	136.30
PRINC. STRN. "	271.64	197.60	145.58

1.00

TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-79.16	-81.95	-43.70
STRAIN B. "	-219.16	-171.95	-123.70
STRAIN C. "	120.84	88.05	56.30
LONG. STRN. "	260.84	178.05	136.30
PRINC. STRN. "	280.84	197.60	145.58

10.00

TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-89.16	-81.95	-53.70
STRAIN B. "	-239.16	-201.95	-153.70
STRAIN C. "	100.84	78.05	76.30
LONG. STRN. "	250.84	198.05	176.30
PRINC. STRN. "	268.61	+217.35	188.64

15.00

TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-89.16	-91.95	-73.70
STRAIN B. "	-289.16	-231.95	-163.70
STRAIN C. "	90.84	108.05	96.30
LONG. STRN. "	290.84	249.05	186.30
PRINC. STRN. "	304.48	268.05	205.85

18.00

TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-99.16	-111.95	-83.70
STRAIN B. "	-319.16	-231.95	-153.70
STRAIN C. "	140.84	158.05	126.30
LONG. STRN. "	360.84	278.05	196.30
PRINC. STRN. "	381.39	311.58	225.38

20.00 (ARC)

TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-129.16	-121.95	-83.70
STRAIN B. "	-299.16	-211.55	-143.70
STRAIN C. "	180.84	188.05	146.30
LONG. STRN. "	350.84	278.05	206.30
PRINC. STRN. "	385.91	322.97	240.70

5.00			
TEMPERATURE	138.98	138.03	137.07
STRAIN A. (MECH.)	99.93	89.26	98.61
STRAIN B. "	-40.07	-10.74	8.61
STRAIN C. "	-180.07	-170.74	-141.39
LONG. STRN. "	-40.07	-70.74	-91.39
PRINC. STRN. "	-180.07	-174.16	-145.08

10.00			
TEMPERATURE	138.98	138.03	137.07
STRAIN A. (MECH.)	139.93	139.26	128.61
STRAIN B. "	-30.07	-40.74	-41.39
STRAIN C. "	-300.07	-230.74	-151.39
LONG. STRN. "	-130.07	-50.74	18.61
PRINC. STRN. "	-305.68	-230.81	-154.57

15.00			
TEMPERATURE	138.98	138.03	137.07
STRAIN A. (MECH.)	289.93	209.26	158.61
STRAIN B. "	-40.07	-70.74	-51.39
STRAIN C. "	-430.07	-230.74	-101.39
LONG. STRN. "	-100.07	49.26	108.61
PRINC. STRN. "	-431.32	-238.77	181.25

17.00			
TEMPERATURE	138.98	138.03	137.07
STRAIN A. (MECH.)	369.93	239.26	158.61
STRAIN B. "	-90.07	-80.74	-91.39
STRAIN C. "	-420.07	-170.74	-51.39
LONG. STRN. "	39.93	149.26	158.61
PRINC. STRN. "	-425.38	269.31	202.10

19.00			
TEMPERATURE	138.98	138.03	137.07
STRAIN A. (MECH.)	449.93	259.26	168.61
STRAIN B. "	-40.07	-40.74	8.61
STRAIN C. "	-280.07	-70.74	8.61
LONG. STRN. "	209.93	229.26	168.61
PRINC. STRN. "	470.74	307.45	201.74

20.00 (ARC)			
TEMPERATURE	139.93	138.03	137.07
STRAIN A. (MECH.)	470.61	269.26	168.61
STRAIN B. "	-9.39	-10.74	18.61
STRAIN C. "	-199.39	-30.74	28.61
LONG. STRN. "	280.61	249.26	178.61
PRINC. STRN. "	500.65	317.75	204.91

22.00			
TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-139.16	-121.95	-83.70
STRAIN B. "	-259.16	-171.95	-123.70
STRAIN C. "	220.84	228.05	166.30
LONG. STRN. "	340.84	278.05	206.30
PRINC. STRN. "	390.69	338.10	248.30

25.00			
TEMPERATURE	126.58	122.76	120.85
STRAIN A. (MECH.)	-88.19	-81.95	-63.70
STRAIN B. "	-158.19	-81.95	-63.70
STRAIN C. "	181.81	228.05	176.30
LONG. STRN. "	251.81	228.05	176.30
PRINC. STRN. "	292.26	292.26	226.00

27.00			
TEMPERATURE	125.62	122.76	120.85
STRAIN A. (MECH.)	-29.16	-31.95	-43.70
STRAIN B. "	-139.16	-41.95	-33.70
STRAIN C. "	110.84	208.05	156.30
LONG. STRN. "	220.84	218.05	146.30
PRINC. STRN. "	233.97	264.57	190.84

30.00			
TEMPERATURE	129.44	122.76	120.85
STRAIN A. (MECH.)	24.84	28.05	6.30
STRAIN B. "	-155.16	-21.95	-13.70
STRAIN C. "	24.84	138.05	116.30
LONG. STRN. "	204.84	188.05	136.30
PRINC. STRN. "	204.84	201.58	154.31

33.00			
TEMPERATURE	134.21	122.76	120.85
STRAIN A. (MECH.)	50.30	58.05	56.30
STRAIN B. "	-209.70	-41.95	-23.70
STRAIN C. "	-29.70	88.05	86.30
LONG. STRN. "	230.30	228.05	166.30
PRINC. STRN. "	233.91	228.14	167.48

38.00			
TEMPERATURE	146.61	122.76	120.85
STRAIN A. (MECH.)	6.91	108.05	96.30
STRAIN B. "	-293.09	-141.95	-93.70
STRAIN C. "	-53.09	48.05	56.30
LONG. STRN. "	246.91	298.05	236.30
PRINC. STRN. "	-294.73	300.09	237.54

21.00			
TEMPERATURE	140.89	138.03	137.07
STRAIN A. (MECH.)	481.31	279.26	188.61
STRAIN B. "	1.31	19.26	28.61
STRAIN C. "	-138.69	29.26	68.61
LONG. STRN. "	341.31	289.26	228.61
PRINC. STRN. "	524.86	338.24	245.23
23.00			
TEMPERATURE	144.70	138.03	137.07
STRAIN A. (MECH.)	464.25	319.26	208.61
STRAIN B. "	34.26	99.26	88.61
STRAIN C. "	-65.74	99.26	108.61
LONG. STRN "	364.25	319.26	228.61
PRINC. STRN. "	511.42	364.82	244.63
25.00			
TEMPERATURE	149.47	138.03	137.07
STRAIN A. (MECH.)	418.28	349.26	238.61
STRAIN B. "	58.28	169.26	138.61
STRAIN C. "	-51.72	149.26	148.61
LONG. STRN. "	308.28	329.26	248.61
PRINC. STRN. "	449.45	377.32	264.67
27.00			
TEMPERATURE	163.78	138.03	137.07
STRAIN A. (MECH.)	377.49	379.26	268.61
STRAIN B "	97.49	219.26	168.61
STRAIN C "	-112.51	149.26	138.61
LONG. STRN. "	167.49	309.26	238.61
PRINC. STRN. "	379.98	387.75	277.43
30.00			
TEMPERATURE	186.68	138.98	137.07
STRAIN A. (MECH.)	354.10	439.93	318.61
STRAIN B. "	124.11	249.93	198.61
STRAIN C. "	-275.89	59.93	88.61
LONG. STRN "	-45.90	249.93	208.61
PRINC. STRN. "	365.37	439.93	318.72
33.00			
TEMPERATURE	207.67	139.93	137.07
STRAIN A. (MECH.)	341.59	470.61	368.61
STRAIN B. "	51.59	190.61	168.61
STRAIN C. "	-498.41	-69.39	-1.39
LONG. STRN. "	-298.41	210.61	198.61
PRINC. STRN. "	-518.07	470.80	369.21
36.00			

45.00			
TEMPERATURE	165.65	124.67	120.85
STRAIN A. (MECH.)	-126.90	45.89	76.30
STRAIN B. "	-316.90	-240.11	-153.70
STRAIN C. "	-46.90	49.89	56.30
LONG. STRN. "	143.10	339.89	286.30
PRINC. STRN. "	-320.35	334.68	286.53
50.00			
TEMPERATURE	178.05	126.58	120.85
STRAIN A. (MECH.)	-178.47	11.91	56.30
STRAIN B. "	-308.47	-258.19	-173.70
STRAIN C. "	-38.47	61.81	66.30
LONG. STRN. "	91.53	341.81	296.30
PRINC. STRN. "	-320.36	342.83	296.35
60.00			
TEMPERATURE	196.22	135.16	121.81
STRAIN A. (MECH.)	-238.75	-48.54	37.17
STRAIN B. "	-268.75	-278.54	-202.84
STRAIN C. "	-28.75	61.46	67.17
LONG. STRN. "	1.21	291.46	307.17
PRINC. STRN. "	-304.82	296.72	307.61
70.00			
TEMPERATURE	208.62	143.75	122.76
STRAIN A. (MECH.)	-286.66	-97.23	-1.95
STRAIN B. "	-216.66	-267.23	-201.95
STRAIN C. "	43.34	122.77	109.05
LONG. STRN. "	-26.66	292.77	303.05
PRINC. STRN. "	-312.06	313.60	313.92
90.00			
TEMPERATURE	215.12	157.11	129.49
STRAIN A. (MECH.)	-296.82	-138.74	-26.19
STRAIN B. "	-166.82	-238.74	-206.19
STRAIN C. "	63.18	111.26	123.81
LONG. STRN. "	-66.82	211.26	303.81
PRINC. STRN. "	-303.63	-271.13	314.61
120.00			
TEMPERATURE	221.38	167.60	135.12
STRAIN A. (MECH.)	-291.23	-174.16	-47.37
STRAIN B. "	-161.23	-224.16	-207.37
STRAIN C. "	68.77	85.84	112.63
LONG. STRN. "	-61.23	135.84	272.64
PRINC. STRN. "	-298.05	-264.20	295.62
560.00			

TEMPERATURE	228.66	141.86	137.07
STRAIN A. (MECH.)	279.33	452.02	388.61
STRAIN B. "	-70.66	82.02	108.61
STRAIN C. "	-620.66	-127.98	-41.39
LONG. STRN. "	-270.67	242.02	238.61
PRINC. STRN. "	-631.66	462.86	398.22
40.00			
TEMPERATURE	251.56	149.07	138.03
STRAIN A. (MECH.)	137.41	344.28	359.26
STRAIN B. "	-152.59	-31.72	19.26
STRAIN C. "	-672.59	-141.72	-50.74
LONG. STRN. "	-382.59	238.28	289.26
PRINC. STRN. "	-688.60	383.01	399.72
45.00			
TEMPERATURE	271.59	158.06	138.98
STRAIN A. (MECH.)	-29.10	183.75	279.93
STRAIN B. "	-179.10	-96.25	-50.07
STRAIN C. "	-699.10	-136.25	-40.07
LONG. STRN. "	-549.10	143.75	289.93
PRINC. STRN. "	-746.79	223.75	353.38
50.00			
TEMPERATURE	283.99	166.65	140.89
STRAIN A. (MECH.)	-170.23	69.43	211.31
STRAIN B. "	-160.23	-120.57	-88.69
STRAIN C. "	-770.23	-120.57	-18.69
LONG. STRN. "	-660.23	69.43	281.31
PRINC. STRN. "	-793.11	-159.92	314.14
55.00			
TEMPERATURE	293.53	176.19	144.70
STRAIN A. (MECH.)	-192.98	-43.83	144.25
STRAIN B. "	-122.97	-113.83	-105.74
STRAIN C. "	-712.97	-123.83	-15.74
LONG. STRN. "	-782.98	-53.83	234.25
PRINC. STRN. "	-873.09	-133.83	252.14
60.00			
TEMPERATURE	300.21	184.77	148.52
STRAIN A. (MECH.)	-225.67	-117.38	97.44
STRAIN B. "	-115.67	-107.38	-112.56
STRAIN C. "	-705.67	-117.38	-2.56
LONG. STRN. "	-815.67	-127.38	207.44
PRINC STRN. "	-890.05	-127.38	215.07
70.00			
TEMPERATURE	306.88	200.04	157.11

TEMPERATURE	138.03	135.16	133.26
STRAIN A. (MECH.)	-144.55	-138.54	-100.83
STRAIN B. "	-244.55	-218.54	-160.83
STRAIN C. "	135.05	81.46	39.17
LONG. STRN. "	235.04	161.46	99.17
PRINC. STRN. "	-282.80	-248.09	-178.48

PASS: 6

0.00			
TEMPERATURE	133.58	136.12	135.16
STRAIN A. (MECH.)	-143.72	-147.37	-128.54
STRAIN B. "	-283.72	-247.37	-218.54
STRAIN C. "	106.28	52.63	41.46
LONG. STRN. "	246.28	152.63	131.46
PRINC. STRN. "	-311.72	-270.97	-238.09
1.00			
TEMPERATURE	138.98	136.12	135.16
STRAIN A. (MECH.)	-143.72	-147.37	-128.54
STRAIN B. "	-283.72	-257.37	-218.54
STRAIN C. "	106.28	52.63	41.46
LONG. STRN. "	246.28	162.63	131.46
PRINC. STRN. "	-311.72	-279.96	-238.09
5.00			
TEMPERATURE	138.98	136.12	135.16
STRAIN A. (MECH.)	-163.72	-157.37	-138.54
STRAIN B. "	-303.72	-267.37	-218.54
STRAIN C. "	96.28	42.63	31.46
LONG. STRN. "	236.28	152.63	111.46
PRINC. STRN. "	-333.38	-289.96	-239.15
10.00			
TEMPERATURE	138.98	136.12	135.16
STRAIN A. (MECH.)	-163.72	-157.37	-129.54
STRAIN B. "	-303.72	-267.37	-218.54
STRAIN C. "	66.28	22.63	11.46
LONG. STRN. "	206.28	132.63	101.46
PRINC. STRN. "	-328.45	-286.68	-233.18
15.00			
TEMPERATURE	138.03	135.16	134.21
STRAIN A. (MECH.)	-134.55	-128.54	-109.70
STRAIN B. "	-324.55	-278.54	-229.70
STRAIN C. "	-4.55	1.46	0.30
LONG. STRN. "	185.05	151.46	120.30
PRINC. STRN. "	-333.11	-288.15	-238.13

STRAIN A. (MECH.)	-268.78	-205.01	33.14
STRAIN B. "	-38.78	-65.02	-86.86
STRAIN C. "	-658.78	-105.02	13.14
LONG. STRN. "	-988.78	-245.01	133.14
PRINC. STRN. "	-931.38	-257.97	133.59
90.00			
TEMPERATURE	304.95	219.12	173.32
STRAIN A. (MECH.)	-277.83	-287.97	-35.72
STRAIN B. "	-37.84	12.03	-35.90
STRAIN C. "	-557.83	-107.97	24.10
LONG. STRN. "	-797.83	-407.97	4.10
PRINC. STRN. "	-822.80	-426.44	-60.62
110.00			
TEMPERATURE	297.34	229.61	184.77
STRAIN A. (MECH.)	-264.44	-300.24	-97.38
STRAIN B. "	65.56	39.76	-7.38
STRAIN C. "	-464.44	-100.24	22.62
LONG. STRN. "	-774.44	-440.24	-67.38
PRINC. STRN. "	-786.46	-460.24	-104.46
150.00			
TEMPERATURE	278.26	234.38	199.08
STRAIN A. (MECH.)	-209.21	-288.24	-135.82
STRAIN B. "	50.79	41.76	14.18
STRAIN C. "	-389.21	-108.24	-15.82
LONG. STRN. "	-649.21	-438.24	-165.82
PRINC. STRN. "	-663.60	-454.56	-183.99
195.00			
TEMPERATURE	236.29	222.93	205.76
STRAIN A. (MECH.)	-87.49	-184.35	-130.09
STRAIN B. "	22.51	15.65	29.91
STRAIN C. "	-267.49	-114.35	-70.09
LONG. STRN. "	-357.49	-314.35	-230.09
PRINC. STRN. "	-373.64	-318.02	-233.50
540.00			
TEMPERATURE	237.67	194.31	184.77
STRAIN A. (MECH.)	11.59	-89.78	-77.38
STRAIN B. "	1.59	-9.78	12.62
STRAIN C. "	-128.41	-69.78	-57.38
LONG. STRN. "	-119.41	-149.78	-147.38
PRINC. STRN. "	-153.60	-150.49	-148.00
900.00			
TEMPERATURE	168.55	167.60	165.69
STRAIN A. (MECH.)	73.74	-19.92	-21.22

18.00			
TEMPERATURE	138.03	135.16	134.21
STRAIN A. (MECH.)	-94.55	-109.54	-89.70
STRAIN B. "	-374.55	-298.54	-229.70
STRAIN C. "	-34.55	21.46	20.30
LONG. STRN. "	245.64	[illegible]	160.30
PRINC. STRN. "	-376.60	-306.6[illegible]	-237.30
20.00 (ARC)			
TEMPERATURE	138.98	135.16	134.21
STRAIN A. (MECH.)	-73.12	-98.54	-79.69
STRAIN B. "	-403.12	-288.54	-219.70
STRAIN C. "	-13.72	51.46	30.30
LONG. STRN. "	316.28	241.46	170.31
PRINC. STRN. "	-404.94	-298.95	-227.30
22.00			
TEMPERATURE	139.98	135.16	134.21
STRAIN A. (MECH.)	-103.72	-88.54	-79.69
STRAIN B. "	-423.12	-269.54	-189.70
STRAIN C. "	66.28	101.46	40.30
LONG. STRN. "	386.28	281.46	150.31
PRINC. STRN. "	-432.54	257.41	-199.97
24.00			
TEMPERATURE	139.98	134.21	134.21
STRAIN A. (MECH.)	-133.72	-69.69	-69.70
STRAIN B. "	-403.72	-229.70	-169.70
STRAIN C. "	136.28	150.30	70.30
LONG. STRN. "	406.28	310.30	170.31
PRINC. STRN. "	428.19	331.95	194.15
26.00			
TEMPERATURE	138.98	134.21	133.26
STRAIN A. (MECH.)	-163.72	-59.70	-50.83
STRAIN B. "	-353.72	-189.70	-150.83
STRAIN C. "	166.28	190.30	89.17
LONG. STRN. "	356.28	310.30	189.17
PRINC. STRN. "	392.75	337.61	203.02
28.00			
TEMPERATURE	140.85	134.21	133.26
STRAIN A. (MECH.)	-161.18	-49.70	-10.83
STRAIN B. "	-291.18	-139.70	-120.83
STRAIN C. "	158.82	180.30	109.17
LONG. STRN. "	288.81	270.30	219.17
PRINC. STRN. "	-332.39	300.36	229.45

STRAIN B. =	-29.26	-39.92	8.78
STRAIN C. =	-69.26	-29.92	-21.22
LONG. STRN. =	30.74	-9.92	-51.22
PRINC. STRN. =	76.90	-40.73	-51.22

1320.00

TEMPERATURE	145.66	147.57	147.57
STRAIN A. (MECH.)	115.03	26.62	6.62
STRAIN B. =	-24.97	-43.38	6.62
STRAIN C. =	-24.97	-3.38	6.62
LONG. STRN. =	115.03	66.63	6.62
PRINC. STRN. =	144.02	68.63	6.62

PASS= 4

0.00

TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	224.26	115.82	95.82
STRAIN B. =	104.26	65.82	105.82
STRAIN C. =	-25.74	-4.18	5.82
LONG. STRN =	94.26	45.82	-4.18
PRINC. STRN. =	224.36	116.65	121.88

1.00

TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	224.26	115.82	95.82
STRAIN B. =	104.26	65.82	115.82
STRAIN C. =	-35.74	-4.18	5.82
LONG. STRN =	84.25	45.82	-14.18
PRINC. STRN. =	224.64	116.65	129.88

5.00

TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	224.26	125.82	115.82
STRAIN B. =	114.26	75.82	115.82
STRAIN C. =	-55.74	-24.18	-24.18
LONG. STRN. =	56.26	25.82	-24.18
PRINC. STRN. =	227.43	129.88	144.81

12.00

TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	264.25	205.82	185.82
STRAIN B. =	134.26	95.82	105.82
STRAIN C. =	-235.74	-164.18	-114.18
LONG. STRN =	-105.75	-54.18	-34.18
PRINC. STRN. =	291.56	220.44	201.35

16.00

31.00

TEMPERATURE	147.57	134.21	133.26
STRAIN A. (MECH.)	-131.67	-9.70	19.17
STRAIN B. =	-231.67	-109.70	-130.83
STRAIN C. =	58.32	150.30	119.17
LONG. STRN. =	158.32	250.30	269.17
PRINC. STRN. =	-233.58	267.28	275.33

35.00

TEMPERATURE	159.97	134.21	133.26
STRAIN A. (MECH.)	-74.88	60.31	29.17
STRAIN B. =	-254.88	-139.70	-160.83
STRAIN C. =	-94.88	70.30	109.17
LONG. STRN. =	85.12	270.31	299.17
PRINC. STRN. =	-255.17	270.37	302.62

40.00

TEMPERATURE	177.14	135.16	133.26
STRAIN A. (MECH.)	-139.54	51.46	49.17
STRAIN B. =	-349.54	-238.54	-190.83
STRAIN C. =	-149.54	11.46	59.17
LONG. STRN. =	60.06	301.46	299.17
PRINC. STRN. =	-350.00	302.20	299.22

45.00

TEMPERATURE	194.31	138.03	133.26
STRAIN A. (MECH.)	-222.06	-4.95	29.17
STRAIN B. =	-362.06	-304.95	-190.83
STRAIN C. =	-132.06	15.05	39.17
LONG. STRN. =	7.94	315.05	259.17
PRINC. STRN. =	-367.46	315.21	259.23

50.00

TEMPERATURE	206.71	140.89	133.26
STRAIN A. (MECH.)	-280.16	-41.18	19.17
STRAIN B. =	-330.16	-331.18	-230.83
STRAIN C. =	-80.16	28.82	49.17
LONG. STRN. =	-30.16	318.82	299.17
PRINC. STRN. =	-360.44	-333.06	299.59

60.00

TEMPERATURE	222.53	150.43	135.16
STRAIN A. (MECH.)	-329.35	-117.42	-18.54
STRAIN B. =	-249.35	-327.42	-248.54
STRAIN C. =	-39.38	42.58	61.46
LONG. STRN. =	-119.35	252.58	291.46
PRINC. STRN. =	-343.25	-338.25	294.41

70.00

TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	424.25	315.82	255.82
STRAIN B. "	84.26	135.82	75.82
STRAIN C. "	-455.74	-254.18	-154.18
LONG. STRN. "	-115.75	-74.18	25.82
PRINC. STRN. "	+466.96	334.55	257.34
18.00			
TEMPERATURE	145.66	147.57	146.61
STRAIN A. (MECH.)	375.03	386.62	295.82
STRAIN B. "	5.03	16.62	65.82
STRAIN C. "	-574.97	-273.38	-154.18
LONG. STRN "	-4.97	96.62	75.82
PRINC. STRN. "	575.05	389.04	295.87
19.00			
TEMPERATURE	146.61	147.57	146.61
STRAIN A. (MECH.)	645.82	406.62	305.82
STRAIN B. "	-74.18	6.62	65.82
STRAIN C. "	-624.18	-263.38	-154.18
LONG. STRN. "	95.82	136.62	85.82
PRINC. STRN. "	651.48	412.87	306.04
20.00 (ARC)			
TEMPERATURE	146.61	147.57	146.61
STRAIN A (MECH.)	665.82	426.62	325.82
STRAIN B. "	-214.18	-23.38	55.82
STRAIN C. "	-614.18	-243.38	-134.18
LONG. STRN. "	265.82	206.62	135.82
PRINC. STRN. "	709.34	445.81	329.27
21.00			
TEMPERATURE	147.57	147.57	146.61
STRAIN A. (MECH.)	606.62	436.62	335.82
STRAIN B. "	-333.38	-43.38	45.82
STRAIN C. "	-513.38	-213.38	-124.18
LONG. STRN "	426.62	266.62	165.82
PRINC. STRN. "	723.38	471.69	343.52
23.00			
TEMPERATURE	156.15	147.57	146.61
STRAIN A. (MECH.)	362.53	406.62	335.82
STRAIN B. "	-447.47	-53.38	35.82
STRAIN C. "	-287.47	-93.38	-74.18
LONG. STRN. "	522.53	366.62	225.82
PRINC. STRN. "	671.36	483.12	356.76
25.00			
TEMPERATURE	171.42	147.57	146.61

TEMPERATURE	228.66	158.06	137.07
STRAIN A. (MECH.)	-339.78	-157.46	-46.17
STRAIN B. "	-185.78	-297.46	-246.17
STRAIN C. "	0.22	72.54	83.83
LONG. STRN. "	-149.78	212.84	283.83
PRINC. STRN. "	-340.96	-322.19	291.69
90.00			
TEMPERATURE	229.61	170.46	162.80
STRAIN A. (MECH.)	-318.37	-189.99	-78.57
STRAIN B. "	-148.37	-259.99	-238.57
STRAIN C. "	11.63	50.01	71.43
LONG. STRN. "	-158.37	120.01	231.43
PRINC. STRN. "	-318.44	-294.71	-250.25
110.00			
TEMPERATURE	223.85	177.14	149.47
STRAIN A. (MECH.)	-287.46	-199.54	-98.77
STRAIN B. "	-147.46	-219.94	-219.78
STRAIN C. "	12.54	30.06	51.22
LONG. STRN. "	-127.46	50.06	171.23
PRINC. STRN. "	-287.80	-262.28	-232.70
140.00			
TEMPERATURE	213.35	180.00	156.15
STRAIN A. (MECH.)	-257.77	-205.49	-120.01
STRAIN B. "	-167.77	-215.45	-200.01
STRAIN C. "	32.23	24.50	29.99
LONG. STRN. "	-57.77	34.50	109.99
PRINC. STRN. "	-267.85	-260.35	-217.20
170.00			
TEMPERATURE	202.90	179.05	159.01
STRAIN A. (MECH.)	-237.06	-156.59	-126.17
STRAIN B. "	-187.06	-206.99	-196.17
STRAIN C. "	32.94	23.01	33.83
LONG. STRN. "	-17.06	33.01	103.83
PRINC. STRN. "	-261.59	-243.77	-216.17
300.00			
TEMPERATURE	177.14	159.51	157.11
STRAIN A. (MECH.)	-189.94	-181.35	-138.74
STRAIN B. "	-219.94	-211.39	-179.74
STRAIN C. "	70.06	28.61	1.26
LONG. STRN. "	100.06	58.61	41.26
PRINC. STRN. "	-266.09	-247.42	-199.12
540.00			
TEMPERATURE	153.29	149.47	146.61

STRAIN A. (MECH.)	112.74	366.62	325.82
STRAIN B. "	-377.26	-33.38	45.82
STRAIN C. "	-107.26	16.62	-14.18
LONG. STRN "	392.74	416.62	265.82
PRINC. STRN. "	399.34	476.67	358.30
27.00			
TEMPERATURE	186.68	148.52	146.61
STRAIN A. (MECH.)	-15.90	327.44	305.82
STRAIN B. "	-225.89	17.44	55.82
STRAIN C. "	-15.89	57.44	35.82
LONG. STRN. "	194.10	407.44	285.82
PRINC. STRN. "	-225.89	438.83	348.16
30.00			
TEMPERATURE	214.35	148.52	146.61
STRAIN A. (MECH.)	-42.40	317.44	305.82
STRAIN B. "	7.61	97.44	105.82
STRAIN C. "	-92.40	137.44	85.82
LONG. STRN "	-142.40	357.44	285.82
PRINC. STRN. "	-146.45	385.56	337.94
32.00			
TEMPERATURE	228.66	149.47	146.61
STRAIN A. (MECH.)	-0.66	318.28	315.82
STRAIN B. "	139.34	158.28	135.82
STRAIN C. "	-240.66	108.28	85.82
LONG. STRN "	-380.66	268.28	265.82
PRINC. STRN. "	-407.02	331.81	332.92
34.00			
TEMPERATURE	242.97	150.43	146.61
STRAIN A. (MECH.)	64.89	339.00	325.82
STRAIN B. "	154.89	149.00	125.82
STRAIN C. "	-415.11	49.00	75.82
LONG. STRN. "	-595.11	239.00	275.82
PRINC. STRN. "	-583.15	345.82	346.59
36.00			
TEMPERATURE	255.37	152.34	147.57
STRAIN A. (MECH.)	98.33	330.16	326.62
STRAIN B. "	88.33	110.16	116.62
STRAIN C. "	-561.67	-9.84	46.62
LONG. STRN "	-551.67	210.16	256.62
PRINC. STRN. "	-691.34	337.36	343.15
40.00			
TEMPERATURE	274.45	159.97	147.57
STRAIN A. (MECH.)	21.12	234.98	306.62

STRAIN A. (MECH.)	-163.76	-158.78	-133.09
STRAIN B. "	-233.76	-208.78	-173.09
STRAIN C. "	96.24	41.22	-3.09
LONG. STRN. "	156.24	91.22	36.91
PRINC. STRN. "	-270.38	-239.05	-191.59
900.00			
TEMPERATURE	135.16	134.22	133.26
STRAIN A. (MECH.)	-138.54	-139.70	-123.83
STRAIN B. "	-238.54	-209.70	-160.83
STRAIN C. "	111.46	70.30	19.17
LONG. STRN. "	211.46	140.30	59.17
PRINC. STRN. "	-270.93	-239.78	-191.21
1500.00			
TEMPERATURE	115.13	115.13	115.13
STRAIN A. (MECH.)	-128.46	-109.46	-98.46
STRAIN B. "	-218.46	-188.46	-138.46
STRAIN C. "	141.54	91.54	31.54
LONG. STRN. "	231.54	171.54	71.54
PRINC. STRN. "	-268.53	-214.37	-156.95
10000.00			
TEMPERATURE	64.57	62.66	63.61
STRAIN A. (MECH.)	-27.51	-6.67	12.00
STRAIN B. "	-167.51	-36.67	-57.10
STRAIN C. "	222.49	193.33	132.90
LONG. STRN. "	362.49	273.33	202.90
PRINC. STRN. "	390.49	296.29	214.09

PASS= 3

0.00			
TEMPERATURE	135.16	132.30	131.35
STRAIN A. (MECH.)	-28.54	-71.54	-53.04
STRAIN B. "	-88.54	-51.54	-43.04
STRAIN C. "	151.46	58.06	66.96
LONG. STRN. "	211.46	78.06	56.96
PRINC. STRN. "	236.39	120.06	95.07
1.00			
TEMPERATURE	135.16	132.30	131.35
STRAIN A. (MECH.)	-18.54	-71.54	-53.04
STRAIN B. "	-98.54	-51.54	-43.04
STRAIN C. "	141.46	58.06	66.96
LONG. STRN. "	211.46	78.06	56.96
PRINC. STRN. "	221.46	120.06	95.07

STRAIN B. "	-48.88	24.98	76.62
STRAIN C. "	-678.88	-65.02	26.62
LONG. STRN. "	-608.88	144.98	256.62
PRINC. STRN. "	-777.10	246.53	333.06

45.00

TEMPERATURE	292.57	168.55	149.47
STRAIN A. (MECH.)	-92.64	120.74	258.28
STRAIN B. "	-112.64	-29.26	38.25
STRAIN C. "	-712.64	-89.26	18.28
LONG. STRN. "	-692.64	60.74	138.28
PRINC. STRN. "	-927.14	129.98	294.48

50.00

TEMPERATURE	304.02	179.05	152.34
STRAIN A. (MECH.)	-177.38	28.28	220.16
STRAIN B. "	-87.38	-31.72	20.16
STRAIN C. "	-707.38	-81.72	30.16
LONG. STRN "	-797.38	-21.72	230.16
PRINC. STRN. "	-885.38	-81.95	266.76

60.00

TEMPERATURE	317.38	197.17	159.97
STRAIN A (MECH.)	-244.89	-87.42	134.98
STRAIN B. "	15.11	12.58	14.98
STRAIN C. "	-664.89	-47.42	64.98
LONG. STRN. "	-924.89	-147.42	184.98
PRINC STRN. "	-969.67	-149.88	191.90

70.00

TEMPERATURE	320.24	213.39	169.51
STRAIN A. (MECH.)	-256.81	-173.27	61.40
STRAIN B. "	83.19	56.73	31.40
STRAIN C "	-626.81	-53.27	71.40
LONG. STRN. "	-966.81	-283.27	101.40
PRINC. STRN. "	-998.45	-293.54	101.76

85.00

TEMPERATURE	317.38	228.66	182.86
STRAIN A. (MECH.)	-234.89	-220.66	1.16
STRAIN B. "	145.11	109.33	61.16
STRAIN C. "	-564.89	-60.66	71.16
LONG. STRN. "	-944.89	-390.66	11.16
PRINC. STRN. "	-969.32	-403.15	79.17

100.00

TEMPERATURE	307.84	236.29	192.40
STRAIN A. (MECH.)	-219.28	-247.49	-31.34
STRAIN B. "	180.72	132.51	98.66

5.00

TEMPERATURE	136.12	133.26	132.30
STRAIN A. (MECH.)	-7.37	-60.83	-41.94
STRAIN B. "	-77.37	-50.83	-41.94
STRAIN C. "	122.63	79.17	48.06
LONG. STRN. "	192.63	69.17	48.06
PRINC. STRN. "	207.47	101.36	66.70

10.00

TEMPERATURE	136.12	133.26	132.30
STRAIN A. (MECH.)	22.63	-10.83	-1.94
STRAIN B. "	-47.37	-40.83	-41.94
STRAIN C. "	52.63	9.17	-1.94
LONG. STRN. "	122.63	39.17	38.06
PRINC. STRN. "	123.55	-42.06	-41.94

13.00

TEMPERATURE	136.12	133.26	132.30
STRAIN A. (MECH.)	92.63	39.17	38.06
STRAIN B. "	-27.37	-50.83	-51.94
STRAIN C. "	-67.37	-60.83	-41.94
LONG. STRN. "	52.63	29.17	48.06
PRINC. STRN. "	102.08	-74.86	-65.97

15.00

TEMPERATURE	137.07	133.26	132.30
STRAIN A. (MECH.)	183.83	89.17	68.06
STRAIN B. "	-46.17	-70.83	-71.94
STRAIN C. "	-166.17	-90.83	-51.94
LONG. STRN. "	63.83	69.17	88.06
PRINC. STRN. "	192.27	-114.65	108.06

18.00

TEMPERATURE	138.03	134.21	132.30
STRAIN A. (MECH.)	225.05	150.30	98.06
STRAIN B. "	-204.55	-149.70	-111.94
STRAIN C. "	-344.55	-119.70	-61.94
LONG. STRN. "	185.05	180.30	148.06
PRINC. STRN. "	+391.57	228.49	170.70

20.00 (ARC)

TEMPERATURE	137.07	134.21	132.30
STRAIN A. (MECH.)	373.83	160.30	98.06
STRAIN B. "	-386.17	-199.69	-131.94
STRAIN C. "	-356.17	-99.70	-51.94
LONG. STRN. "	403.83	260.30	178.06
PRINC. STRN. "	546.65	294.50	195.25

22.00

STRAIN C. "	-499.28	-67.49	48.66
LONG. STRN. "	-899.28	-447.49	-81.34
PRINC. STRN. "	-917.13	-461.13	107.15

120.00

TEMPERATURE	298.30	242.01	201.56
STRAIN A. (MECH.)	-174.86	-235.42	-63.39
STRAIN B. "	185.16	144.58	116.61
STRAIN C. "	-444.86	-85.42	26.61
LONG. STRN "	-804.86	-465.42	-153.39
PRINC. STRN. "	-822.92	-474.51	-160.69

150.00

TEMPERATURE	282.08	242.01	209.58
STRAIN A. (MECH.)	-119.84	-215.42	-86.71
STRAIN B. "	190.16	134.58	123.29
STRAIN C. "	-389.84	-105.42	-6.71
LONG. STRN "	-699.84	-455.42	-216.71
PRINC. STRN. "	-719.86	-460.51	-221.35

290.00

TEMPERATURE	237.24	225.79	213.39
STRAIN A. (MECH.)	92.87	-101.98	-73.27
STRAIN B. "	142.87	98.02	106.73
STRAIN C. "	-227.13	-101.98	-53.27
LONG. STRN. "	-277.13	-301.98	-233.27
PRINC. STRN. "	-331.13	-301.98	-233.56

540.00

TEMPERATURE	212.44	194.31	189.54
STRAIN A. (MECH.)	95.86	-9.78	-13.64
STRAIN B. "	125.86	80.22	116.36
STRAIN C. "	-134.14	-69.78	-43.64
LONG. STRN "	-164.14	-159.78	-173.64
PRINC. STRN. "	-204.20	-163.48	-174.41

960.00

TEMPERATURE	171.42	170.46	170.46
STRAIN A. (MECH.)	142.74	72.07	42.07
STRAIN B. "	102.74	72.07	112.07
STRAIN C. "	-57.26	-27.93	2.07
LONG. STRN. "	-17.26	-27.93	-67.93
PRINC. STRN. "	159.36	92.78	114.27

1500.00

TEMPERATURE	145.66	146.61	148.52
STRAIN A. (MECH.)	175.03	115.82	77.44
STRAIN B. "	105.03	65.82	107.44
STRAIN C. "	-24.97	-4.18	17.44

TEMPERATURE	137.07	133.26	132.30
STRAIN A. (MECH.)	263.83	129.17	88.06
STRAIN B. "	-566.17	-240.83	-161.94
STRAIN C. "	-236.17	-30.83	-11.94
LONG. STRN. "	593.83	339.17	238.06
PRINC. STRN. "	645.41	350.00	244.21

24.00

TEMPERATURE	137.07	133.26	132.30
STRAIN A. (MECH.)	63.83	79.17	68.06
STRAIN B. "	-636.17	-250.83	-161.94
STRAIN C. "	-56.17	59.17	28.06
LONG. STRN. "	643.83	385.17	258.06
PRINC. STRN. "	646.64	389.33	259.01

26.00

TEMPERATURE	140.85	132.30	132.30
STRAIN A. (MECH.)	-121.18	28.06	38.06
STRAIN B. "	-591.18	-231.94	-151.94
STRAIN C. "	88.82	138.06	78.06
LONG. STRN. "	558.82	398.06	268.06
PRINC. STRN. "	-600.69	402.82	269.01

28.00

TEMPERATURE	146.61	132.30	132.30
STRAIN A. (MECH.)	-223.09	-11.94	28.06
STRAIN B. "	-493.09	-201.94	-141.94
STRAIN C. "	146.91	188.06	98.06
LONG. STRN. "	416.90	378.06	268.06
PRINC. STRN. "	-525.27	394.81	271.02

30.00

TEMPERATURE	156.15	133.26	131.35
STRAIN A. (MECH.)	-270.01	-20.83	16.96
STRAIN B. "	-370.01	-170.83	-123.04
STRAIN C. "	119.99	209.17	126.96
LONG. STRN. "	219.99	359.17	266.96
PRINC. STRN. "	-428.63	383.05	274.57

33.00

TEMPERATURE	170.46	133.26	130.39
STRAIN A. (MECH.)	-239.99	-20.83	5.89
STRAIN B. "	-259.99	-140.83	-104.11
STRAIN C. "	20.01	179.17	145.89
LONG. STRN. "	40.01	299.17	255.89
PRINC. STRN. "	-308.49	320.93	269.02

36.00

TEMPERATURE	183.82	133.26	130.39

LONG. STRN. "	45.03	45.82	-12.56
PRINC. STRN. "	179.43	116.65	114.53

PASS= 6

-20.00			
TEMPERATURE	144.79	146.61	146.61
STRAIN A. (MECH.)	244.25	165.82	125.82
STRAIN B. "	144.26	115.82	155.82
STRAIN C. "	4.26	25.82	35.82
LONG. STRN. "	84.25	75.82	5.82
PRINC. STRN. "	259.75	168.62	168.28
-15.00			
TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	244.25	165.82	125.82
STRAIN B. "	174.26	125.82	165.82
STRAIN C. "	4.26	25.82	35.82
LONG. STRN. "	74.25	65.82	-4.18
PRINC. STRN. "	254.26	171.98	177.00
0.00			
TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	274.25	215.82	185.82
STRAIN B. "	264.25	205.82	225.82
STRAIN C. "	-15.74	-4.18	-4.18
LONG. STRN. "	-5.75	5.82	-44.18
PRINC. STRN. "	327.37	254.48	255.89
1.00			
TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	274.25	225.82	195.82
STRAIN B. "	274.25	215.82	235.82
STRAIN C. "	-25.74	-4.18	-14.18
LONG. STRN. "	-25.75	5.82	-54.18
PRINC. STRN. "	335.30	266.54	269.84
5.00			
TEMPERATURE	144.70	146.61	146.61
STRAIN A. (MECH.)	314.25	255.82	235.82
STRAIN B. "	334.26	255.82	255.82
STRAIN C. "	-65.74	-64.18	-54.18
LONG. STRN. "	-85.75	-64.18	-74.18
PRINC. STRN. "	407.45	322.09	310.48
10.00			
TEMPERATURE	145.66	148.52	146.61
STRAIN A. (MECH.)	415.03	367.44	335.82

STRAIN A. (MECH.)	-229.44	-10.83	15.89
STRAIN B. "	-239.44	-140.83	-94.11
STRAIN C. "	-49.44	159.17	145.89
LONG. STRN. "	-39.44	289.17	255.89
PRINC. STRN. "	-273.98	305.36	267.57
40.00			
TEMPERATURE	201.54	135.16	130.39
STRAIN A. (MECH.)	-258.76	28.54	15.89
STRAIN B. "	-258.76	-178.54	-114.11
STRAIN C. "	-48.76	131.46	145.89
LONG. STRN. "	-48.76	281.46	275.89
PRINC. STRN. "	-302.25	294.57	286.44
45.00			
TEMPERATURE	216.25	138.58	131.35
STRAIN A. (MECH.)	-342.33	-93.72	-13.04
STRAIN B. "	-212.33	-203.72	-113.04
STRAIN C. "	-12.33	156.28	166.96
LONG. STRN. "	-142.33	266.28	266.96
PRINC. STRN. "	-346.00	297.46	287.20
55.00			
TEMPERATURE	232.47	148.52	132.30
STRAIN A. (MECH.)	-394.14	-150.23	-31.94
STRAIN B. "	-124.14	-200.24	-131.94
STRAIN C. "	-24.14	169.76	178.06
LONG. STRN. "	-294.14	219.76	278.06
PRINC. STRN. "	-412.73	273.77	303.38
70.00			
TEMPERATURE	242.01	163.78	136.12
STRAIN A. (MECH.)	-380.25	-199.59	-67.37
STRAIN B. "	-40.29	-149.59	-127.37
STRAIN C. "	69.71	160.41	182.63
LONG. STRN. "	-270.29	110.41	242.64
PRINC. STRN. "	-407.98	-241.63	280.91
90.00			
TEMPERATURE	241.06	176.19	142.80
STRAIN A. (MECH.)	-321.66	-211.40	-78.57
STRAIN B. "	-1.66	-111.40	-118.57
STRAIN C. "	68.34	128.60	161.43
LONG. STRN. "	-251.66	28.60	201.43
PRINC. STRN. "	-359.28	-225.25	241.43
120.00			
TEMPERATURE	230.56	194.77	153.29
STRAIN A. (MECH.)	-276.55	-227.91	-103.76

STRAIN B. =	415.03	277.44	245.82
STRAIN C. =	-224.97	-182.56	-154.18
LONG. STRN. =	-224.97	-92.56	-64.18
PRINC. STRN. =	547.58	423.88	380.73
12.00			
TEMPERATURE	145.66	149.47	146.61
STRAIN A. (MECH.)	495.03	438.28	365.82
STRAIN B. =	425.03	268.28	225.82
STRAIN C. =	-334.97	-251.72	-184.18
LONG. STRN. =	-264.97	-81.72	-44.18
PRINC. STRN. =	619.71	480.12	397.17
14.00			
TEMPERATURE	146.61	149.47	146.61
STRAIN A. (MECH.)	635.82	498.28	405.82
STRAIN B. =	395.82	238.28	205.82
STRAIN C. =	-524.18	-321.72	-224.18
LONG. STRN. =	-314.18	-61.72	-24.18
PRINC. STRN. =	708.09	524.86	426.15
16.00			
TEMPERATURE	149.47	149.47	147.57
STRAIN A. (MECH.)	768.28	558.28	426.62
STRAIN B. =	248.28	168.28	166.62
STRAIN C. =	-711.72	-371.72	-233.38
LONG. STRN. =	-191.72	18.28	26.62
PRINC. STRN. =	833.29	564.29	433.97
18.00			
TEMPERATURE	152.34	149.47	147.57
STRAIN A. (MECH.)	870.16	598.28	446.62
STRAIN B. =	-29.84	98.28	136.62
STRAIN C. =	-789.84	-361.72	-233.38
LONG. STRN. =	110.16	138.28	76.62
PRINC. STRN. =	873.11	598.69	447.94
19.00			
TEMPERATURE	155.20	149.47	147.57
STRAIN A. (MECH.)	811.93	588.28	456.62
STRAIN B. =	-208.07	58.28	116.62
STRAIN C. =	-758.07	-331.72	-213.38
LONG. STRN. =	261.93	198.28	126.62
PRINC. STRN. =	846.35	593.57	456.66
20.00 (ARC)			
TEMPERATURE	159.97	150.43	147.57
STRAIN A. (MECH.)	674.98	569.00	446.62
STRAIN B =	-375.02	9.00	106.62

STRAIN B. =	-6.55	-77.31	-93.76
STRAIN C. =	93.05	102.09	136.24
LONG. STRN. =	-176.55	-47.91	126.24
PRINC. STRN. =	-295.54	-229.59	179.03
170.00			
TEMPERATURE	213.39	166.68	161.88
STRAIN A. (MECH.)	-217.77	-204.81	132.25
STRAIN B. =	-37.77	-64.81	-72.25
STRAIN C. =	82.23	85.19	97.75
LONG. STRN. =	-97.77	-54.81	37.75
PRINC. STRN. =	-220.74	-204.89	-144.73
300.00			
TEMPERATURE	181.91	174.28	151.88
STRAIN A. (MECH.)	-172.49	-194.30	-142.25
STRAIN B. =	-92.49	-64.30	-62.25
STRAIN C. =	107.51	85.70	67.75
LONG. STRN. =	27.51	-44.30	-12.25
PRINC. STRN. =	-184.80	-194.66	-145.19
540.00			
TEMPERATURE	157.11	153.29	149.47
STRAIN A. (MECH.)	-128.74	-173.76	-128.78
STRAIN B. =	-108.74	-103.76	-58.78
STRAIN C. =	141.26	86.24	61.22
LONG. STRN. =	121.26	16.24	-8.77
PRINC. STRN. =	183.60	-186.93	-132.01
1140.00			
TEMPERATURE	128.45	126.58	127.53
STRAIN A. (MECH.)	-86.15	-108.19	-107.20
STRAIN B. =	-76.15	-38.19	-27.20
STRAIN C. =	203.61	151.81	102.80
LONG. STRN. =	193.81	91.91	22.80
PRINC. STRN. =	256.92	164.58	-110.14

PASS= 14

-20.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-68.54	-119.69	-98.54
STRAIN B. =	71.46	80.30	91.46
STRAIN C. =	181.46	140.30	101.46
LONG. STRN. =	41.46	-59.70	-98.54
PRINC. STRN. =	182.36	157.55	135.93

-10.00

STRAIN C. "	-675.02	-321.00	-203.38
LONG. STRN. "	374.98	239.00	136.62
PRINC. STRN. "	-772.19	583.62	446.97
21.00			
TEMPERATURE	166.65	150.43	147.57
STRAIN A. (MECH.)	489.43	559.00	436.62
STRAIN B. "	-470.57	-11.00	76.62
STRAIN C. "	-550.57	-271.00	-183.38
LONG. STRN "	409.43	299.00	176.62
PRINC. STRN. "	-711.75	587.00	440.63
22.00			
TEMPERATURE	173.32	149.47	147.57
STRAIN A. (MECH.)	304.10	508.28	426.62
STRAIN B. "	-525.90	-41.72	66.62
STRAIN C. "	-385.90	-211.72	-153.38
LONG. STRN. "	444.10	338.28	206.62
PRINC. STRN. "	-636.09	555.34	434.95
24.00			
TEMPERATURE	188.59	150.43	147.57
STRAIN A. (MECH.)	25.61	429.00	396.62
STRAIN B. "	-444.39	-61.00	46.62
STRAIN C. "	-164.39	-91.00	-93.38
LONG. STRN. "	305.60	399.00	256.62
PRINC. STRN. "	-456.24	516.13	418.17
26.00			
TEMPERATURE	205.76	150.43	147.57
STRAIN A. (MECH.)	-130.09	349.00	356.62
STRAIN B "	-260.09	-41.00	36.62
STRAIN C. "	-80.09	-1.00	-43.38
LONG. STRN. "	49.91	389.00	276.62
PRINC. STRN. "	-262.09	451.22	389.86
28.00			
TEMPERATURE	220.07	151.38	147.57
STRAIN A. (MECH.)	-117.07	299.58	326.62
STRAIN B. "	-77.07	-0.42	46.62
STRAIN C. "	-117.07	39.58	-3.38
LONG. STRN. "	-157.07	339.58	276.62
PRINC. STRN. "	-157.07	383.59	362.74
30.00			
TEMPERATURE	233.43	152.34	147.57
STRAIN A. (MECH.)	-68.62	270.16	296.62
STRAIN B. "	51.38	40.16	56.62
STRAIN C. "	-198.62	70.16	36.62

TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-68.54	-109.69	-88.54
STRAIN B. "	71.46	80.30	101.46
STRAIN C. "	181.46	150.30	101.46
LONG. STRN. "	41.46	-39.69	-88.54
PRINC. STRN. "	182.36	163.48	140.81
0.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-18.54	-69.69	-49.54
STRAIN B. "	141.46	140.30	121.46
STRAIN C. "	191.46	140.30	91.46
LONG. STRN. "	31.46	-69.69	-78.54
PRINC. STRN. "	204.95	183.80	143.52
1.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-18.54	-59.70	-38.54
STRAIN B. "	141.46	150.30	121.46
STRAIN C. "	191.46	140.30	91.46
LONG. STRN. "	31.46	-69.70	-68.54
PRINC. STRN. "	204.99	188.57	141.57
5.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	11.46	-19.70	-8.54
STRAIN B. "	181.46	170.31	131.46
STRAIN C. "	161.46	120.30	61.46
LONG. STRN. "	-8.54	-69.70	-78.54
PRINC. STRN. "	207.50	189.23	137.14
10.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	71.46	30.30	31.46
STRAIN B. "	231.46	180.30	121.46
STRAIN C. "	91.46	40.30	11.46
LONG. STRN. "	-68.54	-109.70	-78.54
PRINC. STRN. "	231.79	180.39	121.96
13.00			
TEMPERATURE	134.21	133.26	134.21
STRAIN A. (MECH.)	170.30	109.17	90.31
STRAIN B. "	260.30	169.17	110.30
STRAIN C. "	-59.70	-50.83	-39.69
LONG. STRN. "	-149.70	-110.83	-59.69
PRINC. STRN. "	290.36	190.42	132.31
15.00			
TEMPERATURE	134.21	133.26	134.21

LONG. STRN =	-318.62	300.16	276.62
PRINC. STRN. =	-329.71	334.17	336.92
33.00			
TEMPERATURE	248.69	154.24	147.57
STRAIN A. (MECH.)	-63.36	231.34	266.62
STRAIN B. =	55.64	51.34	76.62
STRAIN C. =	-343.36	61.34	56.62
LONG. STRN =	-463.36	241.34	246.62
PRINC. STRN. =	-498.66	273.81	296.72
36.00			
TEMPERATURE	262.08	158.06	147.57
STRAIN A. (MECH.)	-90.35	183.75	246.62
STRAIN B. =	59.66	63.75	86.62
STRAIN C. =	-453.34	33.75	66.62
LONG. STRN =	-633.34	153.75	226.62
PRINC. STRN. =	-646.24	196.21	270.64
40.00			
TEMPERATURE	274.45	165.69	149.47
STRAIN A. (MECH.)	-118.88	148.78	238.28
STRAIN B. =	91.12	88.78	108.28
STRAIN C =	-498.88	18.78	78.28
LONG. STRN. =	-708.88	78.78	208.28
PRINC. STRN. =	-751.71	148.97	252.62
45.00			
TEMPERATURE	286.85	173.32	151.38
STRAIN A (MECH.)	-140.92	94.10	219.58
STRAIN B. =	149.09	124.10	139.58
STRAIN C. =	-530.91	14.10	99.58
LONG. STRN. =	-820.92	-15.90	179.58
PRINC. STRN. =	-858.65	134.72	227.83
50.00			
TEMPERATURE	295.44	182.86	154.24
STRAIN A. (MECH.)	-153.68	41.16	181.34
STRAIN B. =	216.32	161.16	151.34
STRAIN C. =	-533.68	21.16	101.34
LONG. STRN. =	-933.68	-98.84	131.34
PRINC STRN. =	-935.04	161.54	182.57
60.00			
TEMPERATURE	302.11	199.08	162.83
STRAIN A. (MECH.)	-146.50	-45.82	136.86
STRAIN B. =	323.50	234.18	186.86
STRAIN C. =	-496.50	44.18	146.86
LONG. STRN. =	-966.50	-235.82	96.86

STRAIN A. (MECH.)	320.30	199.17	130.31
STRAIN B. =	270.30	129.17	70.30
STRAIN C. =	-219.70	-130.83	-69.69
LONG. STRN. =	-169.70	-70.83	-9.69
PRINC. STRN. =	398.59	217.85	138.01
18.00			
TEMPERATURE	134.21	133.26	134.21
STRAIN A. (MECH.)	550.30	269.17	160.30
STRAIN B. =	20.30	29.17	10.30
STRAIN C. =	-519.70	-200.83	-99.70
LONG. STRN. =	10.30	39.17	50.31
PRINC. STRN. =	550.33	265.22	161.83
20.00 (ARC)			
TEMPERATURE	134.21	134.21	134.21
STRAIN A. (MECH.)	610.30	290.30	170.31
STRAIN B. =	-295.65	-65.70	-39.70
STRAIN C. =	-619.70	-179.70	-89.70
LONG. STRN. =	290.30	170.30	120.31
PRINC. STRN. =	-686.75	309.73	192.95
22.00			
TEMPERATURE	136.12	134.21	134.21
STRAIN A. (MECH.)	432.63	240.30	160.30
STRAIN B. =	-607.37	-109.70	-79.70
STRAIN C. =	-517.37	-149.70	-59.70
LONG. STRN. =	522.63	200.30	180.31
PRINC. STRN. =	-780.50	254.40	220.60
24.00			
TEMPERATURE	141.84	134.21	134.21
STRAIN A. (MECH.)	140.11	180.31	130.31
STRAIN B. =	-759.89	-229.70	-109.70
STRAIN C. =	-305.89	-39.70	-19.70
LONG. STRN. =	590.11	350.30	220.31
PRINC. STRN. =	-796.40	371.14	236.55
26.00			
TEMPERATURE	149.47	134.21	134.21
STRAIN A. (MECH.)	-119.78	100.31	100.30
STRAIN B. =	-728.77	-229.70	-119.70
STRAIN C. =	-128.78	50.30	30.30
LONG. STRN. =	481.22	380.30	250.30
PRINC. STRN. =	-728.79	381.33	253.59
28.00			
TEMPERATURE	162.83	133.26	134.21
STRAIN A. (MECH.)	-290.53	29.17	60.30

PRINC. STRN. =	-989.82	-240.09	187.13
70.00			
TEMPERATURE	332.11	209.58	170.46
STRAIN A. (MECH.)	-126.50	-106.71	82.07
STRAIN B. =	493.50	293.29	222.07
STRAIN C. =	-456.50	53.29	162.07
LONG. STRN. =	-986.50	-346.71	22.07
PRINC. STRN. =	-1005.82	-356.56	229.77
90.00			
TEMPERATURE	295.44	224.84	184.77
STRAIN A. (MECH.)	-193.68	-132.51	22.62
STRAIN B. =	416.32	327.49	252.62
STRAIN C. =	-473.68	77.49	142.62
LONG. STRN =	-923.68	-432.51	-87.38
PRINC. STRN. =	-949.27	-440.84	262.90
110.00			
TEMPERATURE	283.99	230.56	194.31
STRAIN A. (MECH.)	-79.23	-129.83	0.22
STRAIN B. =	409.77	320.17	260.22
STRAIN C. =	-369.23	-19.83	110.21
LONG. STRN. =	-849.23	-469.82	-149.79
PRINC. STRN. =	-856.83	-473.64	267.46
150.00			
TEMPERATURE	263.95	230.56	203.85
STRAIN A. (MECH.)	-19.04	-139.83	-21.75
STRAIN B. =	369.96	300.17	278.25
STRAIN C. =	-390.03	-59.83	48.25
LONG. STRN. =	-689.04	-469.82	-251.75
PRINC. STRN. =	-699.69	-470.64	280.55
314.00			
TEMPERATURE	219.12	211.48	201.94
STRAIN A. (MECH.)	92.03	-5.00	-3.39
STRAIN B. =	292.03	235.00	246.61
STRAIN C. =	-177.97	-55.00	-3.39
LONG. STRN =	-377.97	-295.60	-253.39
PRINC. STRN. =	-474.15	-296.17	+253.39
600.00			
TEMPERATURE	187.63	185.73	183.82
STRAIN A. (MECH.)	134.85	63.36	61.89
STRAIN B. =	234.85	183.36	211.89
STRAIN C. =	-195.15	-46.64	-8.11
LONG. STRN =	-295.15	-166.64	-158.11
PRINC. STRN. =	265.45	191.80	215.17

STRAIN B. =	-580.93	-210.83	-119.70
STRAIN C. =	5.07	112.17	80.30
LONG. STRN. =	299.07	359.17	260.30
PRINC. STRN. =	-605.79	362.70	260.57
30.00			
TEMPERATURE	175.23	153.26	134.21
STRAIN A. (MECH.)	-372.66	-20.63	30.30
STRAIN B. =	-422.86	-180.83	-109.70
STRAIN C. =	47.14	169.17	120.30
LONG. STRN. =	97.14	329.17	260.30
PRINC. STRN. =	-427.07	346.29	265.7
32.00			
TEMPERATURE	187.43	134.21	134.21
STRAIN A. (MECH.)	-383.25	-39.69	10.31
STRAIN B. =	-273.25	-149.70	-89.70
STRAIN C. =	26.75	190.30	150.30
LONG. STRN. =	-93.25	300.30	250.30
PRINC. STRN. =	-404.19	327.99	264.15
36.00			
TEMPERATURE	207.67	135.16	134.21
STRAIN A. (MECH.)	-348.42	-59.54	-9.79
STRAIN B. =	-178.42	-138.54	-69.70
STRAIN C. =	-58.42	171.46	160.30
LONG. STRN. =	-228.42	251.46	220.31
PRINC. STRN. =	-350.56	292.94	243.38
40.00	ERROR		
TEMPERATURE	222.53	139.03	134.21
STRAIN A. (MECH.)	1600.65	-114.95	-39.69
STRAIN B. =	-139.35	-144.95	-49.70
STRAIN C. =	-59.35	165.05	160.30
LONG. STRN. =	1680.65	195.05	170.31
PRINC. STRN. =	2002.31	245.27	208.97
45.00			
TEMPERATURE	234.38	142.90	134.21
STRAIN A. (MECH.)	-431.34	-148.57	-49.70
STRAIN B. =	-81.34	-138.57	-39.70
STRAIN C. =	-11.34	181.43	170.31
LONG. STRN. =	-261.34	171.43	160.31
PRINC. STRN. =	-473.72	242.92	208.97
55.00			
TEMPERATURE	246.78	154.24	137.07
STRAIN A. (MECH.)	-433.52	-192.52	-56.17
STRAIN B. =	56.48	-82.52	-26.17

1?20.??			
TEMPERATURE	159.01	159.01	159.01
STRAIN A. (MECH.)	174.36	124.36	94.36
STRAIN B. "	214.36	164.36	184.36
STRAIN C. "	-55.64	-5.64	14.36
LONG. STRN. "	-95.64	-45.64	-75.64
PRINC. STRN. "	252.36	182.85	190.37

1260.??			
TEMPERATURE	147.57	148.52	150.43
STRAIN A. (MECH.)	196.62	147.44	119.00
STRAIN B. "	206.62	167.44	189.00
STRAIN C. "	-33.38	17.44	39.00
LONG. STRN "	-43.38	-2.56	-31.00
PRINC. STRN. "	251.48	189.45	196.05

PASS= 8

0.00			
TEMPERATURE	146.61	147.57	147.57
STRAIN A (MECH.)	185.82	136.62	96.62
STRAIN B "	225.82	176.62	196.62
STRAIN C. "	-44.18	-3.38	-3.38
LONG. STRN "	-84.18	-43.38	-103.38
PRINC. STRN. "	263.82	197.01	204.74

1.00			
TEMPERATURE	146.61	147.57	147.57
STRAIN A (MECH.)	185.82	146.62	106.62
STRAIN B. "	225.82	176.62	196.62
STRAIN C. "	-44.18	-3.38	-3.38
LONG. STRN "	-84.18	-33.38	-93.38
PRINC. STRN. "	263.82	200.66	206.70

5.00			
TEMPERATURE	146.61	147.57	147.57
STRAIN A. (MECH.)	195.82	156.62	126.62
STRAIN B. "	245.82	196.62	216.62
STRAIN C. "	-44.18	-13.38	-13.38
LONG. STRN. "	-94.18	-53.38	-103.38
PRINC. STRN. "	283.91	222.79	231.27

10.00			
TEMPERATURE	146.61	147.57	147.57
STRAIN A. (MECH.)	225.82	186.62	156.62
STRAIN B. "	285.82	236.62	236.62
STRAIN C. "	-64.18	-43.38	-33.38

STRAIN C. "	46.48	157.48	193.83
LONG. STRN. "	-443.52	97.48	163.83
PRINC. STRN. "	-540.07	217.72	225.83

65.00			
TEMPERATURE	250.60	164.74	128.03
STRAIN A. (MECH.)	-358.18	-206.25	-64.95
STRAIN B. "	121.82	-29.25	-34.95
STRAIN C. "	41.82	181.75	195.05
LONG. STRN. "	-478.18	1.75	165.05
PRINC. STRN. "	-550.20	-208.83	229.06

80.00			
TEMPERATURE	250.60	177.14	144.70
STRAIN A. (MECH.)	-349.18	-219.94	-75.87
STRAIN B. "	161.82	20.06	-15.87
STRAIN C. "	41.82	140.06	174.13
LONG. STRN. "	-468.18	-99.94	114.13
PRINC. STRN. "	-523.65	-229.68	190.02

100.00			
TEMPERATURE	243.92	187.63	152.34
STRAIN A. (MECH.)	-307.57	-233.25	-94.99
STRAIN B. "	162.43	46.75	-4.99
STRAIN C. "	72.43	106.75	145.01
LONG. STRN. "	-357.57	-173.25	55.01
PRINC. STRN. "	-455.55	-265.73	149.71

130.00			
TEMPERATURE	231.52	152.40	161.88
STRAIN A. (MECH.)	-255.54	-225.30	-122.25
STRAIN B. "	144.46	74.70	17.75
STRAIN C. "	74.46	94.70	127.75
LONG. STRN. "	-325.54	-205.30	-12.25
PRINC. STRN. "	-377.66	-277.91	128.64

210.00			
TEMPERATURE	207.67	199.54	170.46
STRAIN A. (MECH.)	-198.42	-220.10	-139.99
STRAIN B. "	101.58	79.90	50.01
STRAIN C. "	81.58	69.90	90.01
LONG. STRN. "	-218.42	-230.10	-99.99
PRINC. STRN. "	-271.02	-287.35	-162.29

340.00			
TEMPERATURE	180.96	173.32	167.60
STRAIN A. (MECH.)	-144.00	-185.74	-134.16
STRAIN B. "	76.00	84.26	65.84
STRAIN C. "	116.00	94.26	75.84

LONG. STRN =	-124.18	-93.38	-113.38
PRINC. STRN. =	331.92	272.75	260.75
15.00			
TEMPERATURE	146.61	147.57	147.57
STRAIN A. (MECH.)	265.82	236.62	206.62
STRAIN B. =	335.82	256.62	246.62
STRAIN C. =	-124.18	-83.38	-73.38
LONG. STRN =	-194.18	-193.37	-113.38
PRINC. STRN. =	399.83	317.46	294.66
20.00			
TEMPERATURE	146.61	147.57	147.57
STRAIN A. (MECH.)	375.82	316.62	266.62
STRAIN B =	405.82	286.62	246.62
STRAIN C. =	-244.18	-183.38	-153.38
LONG. STRN =	-274.18	-153.38	-133.38
PRINC. STRN. =	525.93	399.64	339.82
23.00			
TEMPERATURE	147.57	151.38	147.57
STRAIN A. (MECH.)	516.62	419.58	326.62
STRAIN B. =	396.62	259.58	216.62
STRAIN C. =	-403.38	-270.42	-203.38
LONG. STRN. =	-283.38	-110.42	-93.38
PRINC. STRN. =	628.64	466.05	368.62
25.00			
TEMPERATURE	149.52	151.38	147.57
STRAIN A. (MECH.)	637.44	469.58	356.62
STRAIN B. =	327.44	209.58	186.62
STRAIN C. =	-562.56	-310.42	-233.38
LONG. STRN =	-252.56	-50.42	-63.38
PRINC. STRN. =	703.85	490.68	382.01
27.00			
TEMPERATURE	150.43	151.38	147.57
STRAIN A. (MECH.)	759.00	509.58	376.62
STRAIN B. =	159.00	129.58	136.62
STRAIN C. =	-721.00	-380.42	-243.38
LONG. STRN =	-121.00	-0.42	-3.38
PRINC. STRN. =	772.13	514.30	384.43
29.00			
TEMPERATURE	150.43	151.38	147.57
STRAIN A. (MECH.)	759.00	519.58	376.62
STRAIN B. =	-131.00	29.58	96.62
STRAIN C. =	-751.00	-380.42	-253.38
LONG. STRN =	139.00	109.58	26.62

LONG. STRN. =	-104.00	-175.74	-124.16
PRINC. STRN. =	-172.11	-236.79	-170.76
570.00			
TEMPERATURE	159.01	156.15	155.20
STRAIN A. (MECH.)	-106.17	-150.01	-121.27
STRAIN B. =	93.83	59.99	88.73
STRAIN C. =	163.83	119.99	88.73
LONG. STRN. =	-36.17	-130.01	-121.27
PRINC. STRN. =	178.66	-192.35	-164.76
560.00			
TEMPERATURE	138.03	136.12	138.03
STRAIN A. (MECH.)	-74.95	-137.37	-94.95
STRAIN B. =	95.05	132.63	95.05
STRAIN C. =	185.05	142.63	95.05
LONG. STRN. =	15.04	-127.37	-94.95
PRINC. STRN. =	191.06	193.68	134.40
1080.00			
TEMPERATURE	133.26	133.26	134.21
STRAIN A. (MECH.)	-70.83	-120.83	-89.70
STRAIN B. =	99.17	119.17	100.30
STRAIN C. =	189.17	149.17	110.30
LONG. STRN. =	19.17	-90.83	-79.69
PRINC. STRN. =	195.18	185.20	144.84
PASS= 17			
-20.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-68.54	-119.69	-88.54
STRAIN B. =	141.46	173.31	151.46
STRAIN C. =	191.46	150.30	101.46
LONG. STRN. =	-18.54	-139.70	-138.54
PRINC. STRN. =	214.10	220.85	179.81
-10.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-48.54	-99.70	-68.54
STRAIN B. =	171.46	180.30	161.46
STRAIN C. =	211.46	160.30	111.46
LONG. STRN. =	-8.54	-119.69	-118.54
PRINC. STRN. =	239.57	228.80	187.89
0.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-8.54	-49.70	-28.54

PRINC. STRN. =	772.98	521.35	378.56
30.00 (ARC PASSES)			
TEMPERATURE	152.43	151.38	147.57
STRAIN A. (MECH.)	679.00	509.58	376.62
STRAIN B. =	-241.00	-0.42	76.62
STRAIN C. =	-681.00	-360.42	-243.38
LONG. STRN. =	239.00	149.58	56.62
PRINC. STRN. =	-722.11	516.00	376.78
32.00			
TEMPERATURE	153.29	152.34	147.57
STRAIN A. (MECH.)	470.75	470.16	366.62
STRAIN B. =	-409.25	-79.84	26.62
STRAIN C. =	-489.25	-289.84	-213.38
LONG. STRN. =	390.75	260.16	126.62
PRINC. STRN. =	-634.07	506.45	370.90
33.00			
TEMPERATURE	155.20	150.43	147.57
STRAIN A. (MECH.)	341.93	429.00	346.62
STRAIN B. =	-438.07	-91.00	36.62
STRAIN C. =	-378.07	-251.00	-193.38
LONG. STRN. =	401.93	269.00	116.62
PRINC. STRN. =	-571.24	473.71	349.57
35.00			
TEMPERATURE	159.97	149.47	147.57
STRAIN A. (MECH.)	124.98	358.28	316.62
STRAIN B. =	-415.02	-121.72	-3.38
STRAIN C. =	-225.02	-171.72	-153.38
LONG. STRN. =	314.98	308.28	166.62
PRINC. STRN. =	-454.81	434.53	331.52
37.00			
TEMPERATURE	167.60	149.47	147.57
STRAIN A. (MECH.)	10.08	298.28	286.62
STRAIN B. =	-319.92	-111.72	-13.38
STRAIN C. =	-129.92	-81.72	-103.38
LONG. STRN. =	200.08	328.28	196.62
PRINC. STRN. =	-329.17	398.97	313.09
39.00			
TEMPERATURE	176.19	149.47	147.57
STRAIN A. (MECH.)	-43.83	258.28	256.62
STRAIN B. =	-223.83	-91.72	-13.38
STRAIN C. =	-113.83	-41.72	-63.38
LONG. STRN. =	66.17	308.28	226.62
PRINC. STRN. =	-227.99	358.28	290.79
STRAIN B. =	251.46	240.30	201.46
STRAIN C. =	201.46	150.30	91.46
LONG. STRN. =	-58.54	-139.70	-138.54
PRINC. STRN. =	283.68	265.01	211.74
1.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	-8.54	-39.69	-18.54
STRAIN B. =	251.46	250.30	201.46
STRAIN C. =	191.46	140.30	81.46
LONG. STRN. =	-68.54	-149.70	-138.54
PRINC. STRN. =	280.14	269.62	208.66
10.00			
TEMPERATURE	135.16	134.21	135.16
STRAIN A. (MECH.)	151.46	170.30	101.46
STRAIN B. =	381.46	290.30	211.46
STRAIN C. =	51.46	-19.70	-18.54
LONG. STRN. =	-178.54	-189.70	-128.54
PRINC. STRN. =	385.89	300.30	221.74
15.00			
TEMPERATURE	137.07	135.16	135.16
STRAIN A. (MECH.)	453.83	281.46	201.46
STRAIN B. =	423.83	241.46	151.46
STRAIN C. =	-216.17	-168.54	-98.54
LONG. STRN. =	-186.17	-128.54	-48.54
PRINC. STRN. =	571.87	347.75	231.74
18.00			
TEMPERATURE	142.80	136.12	135.16
STRAIN A. (MECH.)	701.43	372.63	231.46
STRAIN B. =	311.43	162.63	91.46
STRAIN C. =	-538.57	-257.37	-139.54
LONG. STRN. =	-149.57	-47.37	1.46
PRINC. STRN. =	742.72	389.67	236.85
20.00 (ARC)			
TEMPERATURE	148.52	136.12	135.16
STRAIN A. (MECH.)	819.76	392.63	231.46
STRAIN B. =	39.76	72.63	51.46
STRAIN C. =	-750.23	-277.37	-149.54
LONG. STRN. =	29.76	32.63	31.46
PRINC. STRN. =	815.78	393.24	231.72
22.00			
TEMPERATURE	157.11	136.12	135.16
STRAIN A. (MECH.)	761.26	382.63	231.46
STRAIN B. =	-368.74	-17.37	1.46

41.00

TEMPERATURE	184.77	150.43	147.57
STRAIN A. (MECH.)	-47.38	219.00	236.62
STRAIN B. "	-137.38	-61.00	-3.38
STRAIN C. "	-157.38	-1.00	-23.38
LONG. STRN. "	-67.38	279.00	216.62
PRINC. STRN. "	-167.57	311.49	276.92

45.00

TEMPERATURE	203.99	151.38	147.57
STRAIN A. (MECH.)	-44.21	179.58	196.62
STRAIN B. "	-54.21	-20.42	16.62
STRAIN C. "	-264.23	9.58	16.62
LONG. STRN "	-254.21	209.58	196.62
PRINC. STRN. "	-302.87	237.58	233.90

55.00

TEMPERATURE	232.47	159.01	148.52
STRAIN A. (MECH.)	-119.02	84.36	147.44
STRAIN B. "	-29.02	-5.64	47.44
STRAIN C. "	-349.02	14.36	57.44
LONG. STRN "	-439.02	104.36	157.44
PRINC. STRN. "	-469.07	114.55	173.51

65.00

TEMPERATURE	251.55	169.53	152.34
STRAIN A. (MECH.)	-192.59	-18.60	100.16
STRAIN B. "	77.41	51.40	70.16
STRAIN C. "	-362.59	41.40	100.16
LONG. STRN. "	-632.59	-28.60	130.16
PRINC. STRN. "	-642.62	61.40	130.16

80.00

TEMPERATURE	266.82	186.68	159.01
STRAIN A. (MECH.)	-179.63	-95.89	54.36
STRAIN B. "	270.37	124.11	124.36
STRAIN C. "	-369.63	24.11	104.36
LONG. STRN. "	-749.63	-195.89	34.36
PRINC. STRN. "	-759.04	-206.77	130.84

95.00 ERROR

TEMPERATURE	271.59	200.04	167.62
STRAIN A. (MECH.)	-159.10	-115.02	30.08
STRAIN B. "	240.90	154.98	140.08
STRAIN C. "	-569.10	-5.01	90.08
LONG. STRN "	-969.10	-275.02	-19.92
PRINC. STRN. "	-1002.89	-281.94	145.52

STRAIN C. "	-818.74	-287.37	-138.54
LONG. STRN. "	311.26	132.63	91.46
PRINC. STRN. "	-988.80	393.25	236.85

24.00

TEMPERATURE	164.74	136.12	135.16
STRAIN A. (MECH.)	441.75	322.63	211.46
STRAIN B. "	-688.25	-137.37	-48.54
STRAIN C. "	-678.25	-207.37	-108.54
LONG. STRN. "	451.75	252.63	151.46
PRINC. STRN. "	-917.31	386.65	240.14

26.00

TEMPERATURE	180.00	135.16	135.16
STRAIN A. (MECH.)	94.51	231.46	181.46
STRAIN B. "	-685.49	-208.54	-78.54
STRAIN C. "	-425.50	-128.54	-58.54
LONG. STRN. "	354.50	311.46	201.46
PRINC. STRN. "	-746.87	367.69	245.85

30.00

TEMPERATURE	214.35	136.12	134.21
STRAIN A. (MECH.)	-345.96	62.63	100.30
STRAIN B. "	-515.56	-217.37	-99.70
STRAIN C. "	-5.56	72.63	50.31
LONG. STRN. "	164.04	352.63	250.30
PRINC. STRN. "	-556.10	352.68	252.09

34.00

TEMPERATURE	240.10	139.98	134.21
STRAIN A. (MECH.)	-463.03	-53.72	20.30
STRAIN B. "	-183.03	-163.72	-89.70
STRAIN C. "	66.97	156.28	120.30
LONG. STRN. "	-213.03	266.28	230.30
PRINC. STRN. "	-463.45	250.55	237.93

40.00

TEMPERATURE	260.14	144.70	135.16
STRAIN A. (MECH.)	-445.11	-125.87	-38.54
STRAIN B. "	14.89	-115.87	-58.54
STRAIN C. "	14.89	194.13	191.46
LONG. STRN. "	-445.11	174.13	201.46
PRINC. STRN. "	-540.36	241.38	241.75

45.00

TEMPERATURE	266.82	151.38	135.16
STRAIN A. (MECH.)	-456.22	-166.21	-58.54
STRAIN B. "	83.78	-66.21	-28.54
STRAIN C. "	13.78	193.79	201.46

120.00			
TEMPERATURE	268.72	212.44	180.00
STRAIN A. (MECH.)	-119.40	-134.14	-1.01
STRAIN B. =	250.60	175.86	158.99
STRAIN C. =	-359.40	-54.14	38.99
LONG. STRN =	-729.40	-364.13	-121.01
PRINC. STRN. =	-743.88	-367.08	160.41

140.00			
TEMPERATURE	263.00	217.21	186.68
STRAIN A. (MECH.)	-100.19	-129.75	-15.90
STRAIN B. =	269.81	190.25	164.11
STRAIN C. =	-330.19	-69.75	14.11
LONG. STRN =	-700.19	-389.75	-165.89
PRINC. STRN. =	-713.63	-391.30	-166.57

165.00			
TEMPERATURE	255.37	219.12	193.36
STRAIN A. (MECH.)	-71.67	-107.97	-30.57
STRAIN B. =	278.33	202.03	189.44
STRAIN C. =	-301.67	-87.97	-10.56
LONG. STRN. =	-651.67	-397.97	-230.57
PRINC. STRN. =	-665.67	-398.13	-230.80

295.00			
TEMPERATURE	220.07	208.62	199.08
STRAIN A (MECH.)	22.93	-47.56	-25.82
STRAIN B. =	232.93	192.44	174.18
STRAIN C. =	-187.07	-97.56	-65.82
LONG. STRN. =	-397.07	-337.56	-265.82
PRINC. STRN. =	-414.11	-338.74	-266.73

540.00			
TEMPERATURE	183.82	178.09	177.14
STRAIN A. (MECH.)	91.89	37.57	36.87
STRAIN B. =	211.89	177.57	186.87
STRAIN C. =	-108.11	-92.43	-53.13
LONG. STRN. =	-228.11	-232.43	-203.13
PRINC. STRN. =	-249.77	-242.49	-208.26

906.00			
TEMPERATURE	156.15	150.43	155.20
STRAIN A. (MECH.)	152.53	79.00	41.93
STRAIN B. =	212.53	159.00	171.93
STRAIN C. =	-67.47	-51.00	-38.07
LONG. STRN. =	-127.47	-131.00	-168.07
PRINC. STRN. =	245.02	172.91	176.58

LONG. STRN. =	-526.22	93.79	171.46
PRINC. STRN. =	-606.25	210.77	235.47

55.00			
TEMPERATURE	271.55	163.78	138.03
STRAIN A. (MECH.)	-400.00	-229.59	-64.95
STRAIN B. =	200.00	20.41	5.05
STRAIN C. =	70.00	210.41	235.05
LONG. STRN. =	-530.00	-39.59	165.05
PRINC. STRN. =	-599.11	-231.63	255.05

70.00			
TEMPERATURE	267.77	178.09	142.80
STRAIN A. (MECH.)	-394.97	-238.47	-78.57
STRAIN B. =	275.03	81.53	31.43
STRAIN C. =	75.03	201.53	221.43
LONG. STRN. =	-594.97	-118.47	111.43
PRINC. STRN. =	-654.35	-260.13	226.67

90.00			
TEMPERATURE	258.23	190.50	152.34
STRAIN A. (MECH.)	-327.69	-238.51	-94.99
STRAIN B. =	272.31	121.49	55.01
STRAIN C. =	52.31	151.49	185.01
LONG. STRN. =	-547.69	-218.51	35.01
PRINC. STRN. =	-589.57	-335.52	185.37

120.00			
TEMPERATURE	242.97	197.17	162.83
STRAIN A. (MECH.)	-278.93	-237.14	-120.93
STRAIN B. =	241.07	142.86	69.07
STRAIN C. =	61.07	102.86	149.07
LONG. STRN. =	-458.93	-277.14	-40.93
PRINC. STRN. =	-498.03	-337.32	159.85

170.00			
TEMPERATURE	222.93	197.17	171.42
STRAIN A. (MECH.)	-229.35	-237.14	-159.58
STRAIN B. =	200.65	152.86	91.42
STRAIN C. =	80.65	92.86	101.42
LONG. STRN. =	-349.35	-307.14	-148.58
PRINC. STRN. =	-390.03	-357.32	-205.50

360.00			
TEMPERATURE	178.09	173.32	167.60
STRAIN A. (MECH.)	-148.47	-195.74	-154.16
STRAIN B. =	151.53	154.26	125.84
STRAIN C. =	131.53	104.26	75.84
LONG. STRN. =	-168.47	-245.74	-204.16

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 1260.00
TEMPERATURE              139.93        139.93        140.89
STRAIN A. (MECH.)        180.61        110.61         51.31
STRAIN B.     "          200.61        150.61        161.31
STRAIN C      "          -49.39        -29.39        -38.69
LONG. STRN    "          -69.39        -69.39       -148.69
PRINC. STRN.  "          242.95        171.00        167.71

 5100.00
TEMPERATURE               97.96         98.91         98.91
STRAIN A. (MECH.)        304.96        194.99        154.99
STRAIN B.     "          264.96        224.99        234.99
STRAIN C.     "           54.96         64.99         44.99
LONG. STRN.   "           94.96         34.99        -35.01
PRINC. STRN.  "          331.12        245.09        245.76

 9999.00
TEMPERATURE               91.28         91.28         95.10
STRAIN A. (MECH.)        295.19        195.19        134.97
STRAIN B.     "          255.19        195.19        204.97
STRAIN C.     "           55.19         55.19         44.97
LONG. STRN.   "           95.19         55.19        -25.03
PRINC. STRN.  "          319.41        224.19        213.46

10000.00 (HOLD-DOWN CLAMPS RELEASED)
TEMPERATURE               91.28         91.28         95.10
STRAIN A. (MECH.)        195.19         95.19         54.97
STRAIN B.     "           95.19         35.19         54.97
STRAIN C.     "           25.19       -984.81         24.97
LONG. STRN    "          125.19       -924.81         24.97
PRINC STRN.   "          196.51      -1167.30         61.18

COMPILE TIME=    0.46 SEC.EXECUTION TIME=    6 2  SEC.OBJECT CODE=

COMPILE TIME=    0.01 SEC.EXECUTION TIME=    0.00 SEC.OBJECT CODE=

PRINC. STRN.  "         -221.07       -255.14       -260.28

  530.00
TEMPERATURE              162.93        159.57        158.06
STRAIN A. (MECH.)       -110.93       -164.88       -137.46
STRAIN B.     "          169.07        165.12        152.54
STRAIN C.     "          165.07        135.12        102.54
LONG. STRN.   "         -110.93       -194.88       -197.46
PRINC. STRN.  "          227.06       -249.19       -225.55

  500.00
TEMPERATURE              142.80        140.80        141.84
STRAIN A. (MECH.)        -88.57       -141.18       -119.89
STRAIN B.     "          171.43        179.92        150.11
STRAIN C.     "          181.43        148.82        100.11
LONG. STRN.   "          -78.57       -171.18       -169.89
PRINC. STRN.  "          230.41        231.08       -204.05

 1500.00
TEMPERATURE              122.76        122.76        125.62
STRAIN A. (MECH.)        -51.55       -121.35        -89.16
STRAIN B.     "          188.05        208.05        170.84
STRAIN C.     "          208.05        168.05        130.84
LONG. STRN.   "          -31.55       -161.95       -129.16
PRINC. STRN.  "          248.35        258.10        206.85
PASS 20 (FINAL COOL-DOWN STRAIN STATE)
 5559.00
TEMPERATURE               74.11         73.15         73.15
STRAIN A. (MECH.)        -70.41       -100.21        -90.21
STRAIN B.     "          259.59        279.79        239.79
STRAIN C.     "          189.59        149.79         89.79
LONG. STRN.   "         -140.41       -230.21       -230.21
PRINC. STRN.  "          298.13        308.77        254.69

10000.00 (HOLD-DOWN CLAMPS RELEASED)
TEMPERATURE               73.15         72.20         73.15
STRAIN A. (MECH.)       -100.21       -140.00        -90.21
STRAIN B.     "          139.79        160.00        139.79
STRAIN C.     "          129.79        100.00         39.79
LONG. STRN.   "         -110.21       -200.00       -190.21
PRINC. STRN.  "          184.64       -236.33       -202.55

COMPILE TIME=    0.63 SEC.EXECUTION TIME=    6.43 SEC.OBJECT CODE=

COMPILE TIME=    0.04 SEC.EXECUTION TIME=    0.00 SEC.OBJECT CODE=
```

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Thesis
K576 Klein 127249
Investigation of
welding thermal strains
in marine steels.